SOUTHERN UTAH FUEL COMPANY

MINE PLAN

February 12, 1977

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This booklet and the accompanying two map packets are filed in compliance with the Department of the Interior Regulation Title 30, Chapter II, Part 211 - Coal Mining Operation Regulations.

February 12, 1977

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DESCRIPTION

211.10C (1)

Persons responsible for operations to whom notices and orders are to be delivered:

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Owner of all surface and minerals under Federal Coal Leases U062453, SL062583, U0149084, and U28297 is:

The United States

DESCRIPTION OF ENVIRONMENT
211.10C (2)

Geologic Conditions and Potential Geologic Hazards

The coal which is extracted from the SUFCo Mine occurs in the lower portion of the Blackhawk Formation of the Mesa Verde Group of sediments of Upper Cretaceous age. Doelling identifies the seam as being the Upper Ivie bed while we call it the Upper Hiawatha. The Blackhawk is overlain by the Price River Formation including the Castlegate Sandstone, and is underlain by the Star Point Sandstone all being members of the Mesa Verde Group.

The Price River Formation is the youngest or uppermost competent sedimentary unit exposed in the vicinity of the mine. It is the uppermost member of the Mesa Verde group and consists of "gray to white gritty sandstone interbedded with subordinate shale and conglomerate." The formation is resistant to weathering and is a ledge and slope former. In the vicinity of the mine it is the uppermost unit capping the mesa which forms the Old Woman Plateau. The formation is reported to be about 550 feet thick near the mine.

The Castlegate Sandstone is a massive, cliff-forming, white to gray, coarse-grained sandstone, often conglomeratic, and which weathers brown. It is considered as the basal member of the Price River Formation. It overlies the Blackhawk Formation and is reported as being 90 to 200 feet thick (Doelling). The Castlegate Sandstone, together with the other beds of the Price River Formation, constitutes the cap rock which forms the mesa and plateau landforms near the mine.

The Blackhawk Formation, according to Doelling, consists of "yellow to gray, fine to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale (and having) several thick coal seams." He presents a section

of the Blackhawk Formation measured in Quitchupah Canyon in the SE-1/4, NE-1/4 of Section 8, Township 22 South, Range 5 East as having a thickness of about 670 feet. In this section, the Upper Hiawatha (Ivie) bed lies about 50 feet above the base of the Blackhawk.

The Blackhawk Formation is underlain by the Star Point Sandstone, also of the Mesa Verde Group. The Star Point Sandstone is reported by Doelling as consisting of a "yellow-gray, massive cliff-forming sandstone, often in several tongues separated by Musak Shale." The Star Point Sandstone is from 200 to 300 feet thick near the mine. The contact of the Star Point with the underlying Musak Shale occurs at the bottom of East Spring Canyon near its juncture with Convulsion Canyon.

The Star Point Sandstone is underlain by the Musak Shale, which is described as being a yellow to blue-gray, sandy shale which is equivalent to the upper member of the Mancos Shale. This is the lowest stratigraphic member exposed near the mine and forms the valley floor of Convulsion Canyon and the bottom of Quitchupah Creek eastward from the mine.

The mine area lies midway between the Joe's Valley-Paradise Fault Zone to the east and the Musinia Fault Zone to the west. Consequently, the sediments near the mine are relatively undisturbed. Generally, the sediments have a strike which trends roughly northeast and a shallow dip of about 250 feet per mile to the northwest. A few small faults, having apparent vertical displacement of about 3 feet or less, have been encountered in the mine workings. These faults have a trend of about N 10 to 15° W and are near-vertical. A joint set occurs parallel to the fault trend and another bears a normal or conjugate

relationship. It is along these faults that the underground seepage of water is encountered. This structure has not significantly affected mining.

In the lower elevations east of the mine, the valley of Quitchupah Creek becomes transitional with the gently sloping broad topography of the open plains. This surface is interrupted from place to place by intermittent drainages and resistant knolls of Cretaceous sediments. Soils in this area are derived from the underlying Musak (Mancos) Shale and from colluvium and alluvium derived from the older sediments which were eroded and transported from the highlands to the north and west. Where small patches of land have been cultivated and irrigated, the soils have been derived from the Musak Shale. As is typical of the soils derived from the Mancos, they contain considerable amounts of salts and gypsum and are inherently saline. The soils are sandy and clayey loams and are underlain by alluvial gravels at depths of from 8 to 10 feet. These soils are well-drained.

Types, Depths and Distribution of Soils

Soils are very shallow, sand to silty sand in texture and with high percolation rates. Rock showing at the surface is alternating layers of sandstone and shale. In places there are small amounts of coal and limestone. Soils are highly susceptible to wind erosion but inherent erosion hazard from water is low.

Types, Density, Productivity, Dominance, and Distribution of Vegetation

Vegetation changes from one landform to another. On the benches landform, there is a combination of sagebrush-grass community and ponderosa pine stands. Also occuring intermixed in these types are patches of low quality Quaker Aspen, Mountain Mahogany, and Manzanita brush. Ground cover is composed of several native grasses, forbs, and low brush species. Density is generally good.

The steep slopes and scarp faces landform is sparsely vegetated. Pinyon, Juniper, and Mountain Mahogany are scattered over the landform. Site is very harsh and ground vegetation is limited to light quantities of native grasses and forbs in cracks and shelves where soil can accumulate. Composition includes a few drought resistant grasses, annual forbs, Mountain Mahogany and other brush.

Narrow stringers in canyon bottoms landform is the most productive in the area. Vegetation is primarily native grass, low brush and forbs growing together to form a heavy sod. Brush types include willow, rose, rabbit brush, sand brush and others. Carex grows in some of the wetter spots. Only an occasional tree occurs in the bottoms.

The rolling hills landform is covered by an occasional small patch of trees which include Ponderosa pine, Douglas-fir, Alpine-fir, Spruce and Aspen. More common are brush species including oak, snowberry, and sagebrush. Grasses and forbs are very sparse and include several native species.

No threatened or endangered plants are known to occupy the lease area.

Climatological Data

There is an average frost freeze period of 80 to 100 days. Temperatures range from 12° F to 90° F. The area is characterized by high intensity thunderstorms and associated high winds. Annual precipitation is 12 to 16 inches, the majority occuring during July through October. Monthly average precipitation varies from 0.4 inches to slightly over one inch.

Monthly "Thirty Year Normal" temperature and precipitation from the nearest weather substation are shown on Table 1. The nearest wind reporting weather stations, Greenville and Hanksville, are not representative of this area due to distance, elevation and terrain differences. Prevailing winds are basically up-canyon from SSW to NNE.

YEAR NORMAL TEMPERATURES AND PRECIPITATION

Table 1
Emery, Utah Weather Substation
Thirty Year Normal

	TEMP.	PREC.
January	24.3° F	.47 inch
February	29.0	.41
March	35.7	.45
April	44.7	.42
May	53.5	.62
June	61.1	.69
July	68.3	.71
August	66.1	1.17
September	58.7	.79
October	48.5	.85
November	35.4	.40
December	27.2	.57
Annual mean average	46.0	7.55

Wildlife

The lease has a similar component of animals common to the Old Woman Plateau. Those for which impacts may occur are only a few. Bald eagles have been observed. It is believed they winter in the steep slopes and scarp faces on the eastern edge of the lease. Mule deer use the area for summer range. Elk winter in the lease area. Black bear, coyote and mountain lion are present. The intermittent flow of streams are not capable of supporting fishlife. The only rare and endangered specie that occurs is the bald eagle.

The area does not have wilderness character due to man's past activities.

CONDITION OF THE LAND

211.10C (3)

Use of Land

211.10C (3)i

The surface area is grazed by cattle under the Quitchupah C and H allotment. The allotment is under an intensive rest-rotation management system. Several ranchers in Emery are dependent on the allotment. Structual range improvements include one watering through and two cattle guards on the access route into the lease. Water in the trough is supplied by a spring.

Recreation is primarily big game hunting. It is light, occuring over a month's period of time each year. Snowmobiling also occurs.

The timber on the lease area is open grown Ponderosa pine. All commercial stands occur on the benches. Trees are of low quality because of the poor tree growing site. Cutting is limited to older over-matured trees.

A sales is being prepared that will place logging equipment in the lease area and logging trucks on the main access road toward Salina. No timber impacts are anticipated.

The aestetic value has been categorized by the U.S. Forest Service as follows:

> The mesa rim and deep canyons can be seen as background from Emery (Dog Valley). They are classified as distinctive with variety. Activity from the proposal will not be visually evident from the valley. The lease area is seen as middle ground from a few remote spots on the Duncan Mountain Road. This scene area is presently classified in Sensitivity Level 2 (Average Sensitivity). The visual objective as recommended by the Land Use Plan is 2 (Modification). This permits activities to visually dominate the characteristic landscape. Very few people visit the area and those that do, come for something other than scenic attractions.

211.10C (3)ii

All uses of the land immediately prior to mining and the capability of the land to support prior alternate uses will remain equally available throughout the life of the mine without impact from underground mining except on insignificant levels.

211.10C (4,5)

Land use will remain virtually the same before, during and after mining without effect of the mining. The infinitesimal effect of underground mining on surface use is accounted for as follows:

1. Isolated facilities for duration of the mine, including portal and associated buildings, comprising about ten of the 5,600

acres under consideration, being too small to affect general land use.

2. Gradual and even subsidence over most of the lease being too impreceptible to affect general land use.

Federal comprehensive land use plans have been prepared by the U.S. Forest Service which include the lease area.

Nature, Extent and Reserves
211.10C (6)i

The Upper Hiawatha coal seam is quite uniform in nature as shown on Map 1F. North and west of section 7, T22S, R5E, the thickness is also uniform and averages approximately 15 feet. South and east of this section, a thinning trend is indicated from drill hole information within the section and by Spieker (U.S.G.S. bulletin 819, The Wasatch Plateau Coal Field). This thinning trend continues to the outcrops in Convulsion and Quitchupah Canyons. Drill hole data show 6.3 feet of coal in section 7.

25 million recoverable tons of the Upper Hiawatha seam lie within the boundaries of SUFCo leases and fee land. This has been calculated by applying applicable recovery factors to the panels, barriers, and entries as projected on Maps 1A, 1B, and 1C. Similarly, 14.0 million tons have been calculated recoverable from lease application area U-28297. This calculation also used various recovery factors based upon the projected mine plan. It is assumed that the mined thickness in the southern extent of this area would be no less than 6 feet although Spieker indicates the coal may be thinner. A five hundred foot unmined zone was assumed all along the outcrop since evidence suggests that the outcrop zone was burned in ancient times.

Method of Mining
211.10C (6)ii

The topography of the lease land is mostly a plateau outlined by deep adjoining canyons. From the rim of the canyon to the outcropped coal, the side hill is very steep with many vertical cliff faces (see Map 1B). The outcropped coal has visible evidence of burned zones throughout the lease (see Map 1C).

The mining method used to remove the coal from under the canyon rim to the outcrop should protect the canyon from deterioration. The mine workings should also be protected from cracks or zones that allow air and moisture contamination from the outside where the cover in the canyon is shallow. In case of fire in the mine workings, air leaks to the surface would make fire containment extremely difficult. The uneven boundary of the outcrop line and the possibility of coal void area caused by ancient, naturally burned zones require the mining method in those areas to be flexible enough to mine the coal inclusive to the voids and coal outcrop.

The coal seam lying back away from the canyon rim under the plateau can be sectioned into blocks and zones conductive to high recovery mining methods.

Southern Utah Fuel Company has divided the property into two zones. The first zone will be mined by a first mining method leaving supportative pillars that ensures surface stability. The second zone will be mined by a method called 'second mining' that removes supportative pillars and allows surface subsidence. The zones are shown on Map 1C.

Layout for the development of the property is shown on Map 1A. Development entries are designed with supportative pillars and barrier pillar sizes

large enough to ensure stability with little upkeep maintenance. Mining height in development entries will be kept at a maximum of 9 feet where possible. Continuous mining units and conventional mining units will be used in development mining (refer to 211.10C (6)v for machinery list).

The method of mining called 'first mining' is a room and pillar method which consists of driving entries with connecting crosscuts leaving supportative pillars. Pillar size is determined by depth of cover and sized to ensure stability with high recovery. The sequence of mining will include an advancing panel approximately 800 feet across. All the entries and crosscuts are driven as mining progresses into the panel.

A retreat first mining method will be used under high cover and poor roof conditions if necessary. The retreat first mining method consists of a panel 800 feet wide where half the panel is mined advancing to the boundary of the panel and second half mined coming out of the panel. Recovery in the panels, based on mining height, is expected to be above 50%. Continuous mining units and conventional mining units will be used in first mining.

The method of mining called 'second mining' is a variation of the room and pillar methods. Three or four entries with connecting crosscuts will be driven to the boundary of the panel, usually 2,500 feet. The entries will then be connected to ventilation openings called 'bleeder entries'. Mining will then retreat out of the panel, driving rooms 500 feet to the left of the developed entries and robbing the pillars and chain pillars as mining progresses out of the panel. Coal recovery in the panel based on mining height is expected to be above 75%. Continuous mining units will be used in second mining.

Mining sequence of the property for the next five years is shown on Map 1B. Expected production capacity is as follows:

First year	----------	1.45 million Tpy
Mid-second year	----------	1.75 million Tpy
Third year	----------	1.75 million Tpy
Fourth year	----------	2.1 million Tpy
Fifth year	----------	2.1 million Tpy

NOTE:

Planned development of the new lease east of the One East submains may have to be altered because of uncertainties in the nature of the coal seam. A drilling program is planned in the area after acquisition of the lease.

First and second mining layout dimensions, number of entries, mining height, entry width, ventilation controls, roof controls, etc. must conform to plans which are approved by the mining Enforcement and Safety Administration.

Nature and Timing of Surface Reclamation Measures
211.10C (6)iii

About ten acres of surface is and will be in use throughout the project in the vicinity of the portals. The mine plant is located in this area and consists of buildings, storage yards, and structures necessary to supply and maintain the underground operation. Also, mined coal is crushed and loaded into trucks in this area.

A. Immediately upon completion of mining, all this land will be reclaimed diligently until completion. Drainage structures will be left in place to control erosion. Steel and wood structures not appurtenant to drainage of the area will be removed within 12 months time. Portals will be closed within the first three months. Site will be scarified, sloped and seeded before the next growing season. Grass will be maintained by fertilization or reseeding until stable up to five years.

B. Should access to the mine through one of the existing portals be required by the Geological Survey for future mining or research, then the portal will be semi-permanently closed by embanking fill material against the portal opening that the USGS requests that we abandon in this manner. Otherwise, mine openings will be permanently sealed by construction of substantial walls within the openings and subsequent explosive caving of the roof outside of the wall so as to fill the space and prevent entry; or by emplacement of impervious material within the initial 50 feet of each opening.

C. Concrete foundations will be buried with fill material and covered with topsoil and disced.

D. Entire site will be seeded with a mixture of seed such as mountain varieties of wheatgrass, hard fescue, and Ladak alfalfa, or as specified by the Forest Service.

E. Seed will be planted using tractor and drill or hand spreader and rake at the rate of 15 pounds per acre.

Engineering Techniques Proposed to be used in Mining
211.10C (6)iv

Described in 211.10C (6)ii.

Engineering Techniques Proposed to be used in Reclamation
211.10C (6)iv

About 1,000 feet of road exists on the lease at the mine. This road has been improved for truck haul use and will remain after completion of mining.

The mine-site is isolated from the drainage of East Spring Canyon by a 72-inch culvert. Precipitation runoff from the ten-acre site is channeled through a sediment tank to remove oil, grease and coal fines before discharge into the canyon. The main culvert will remain functional after mining and site restoration to control erosion.

211.10C (6)v

The following is a list of underground equipment now in use. The same type of equipment is expected to be used in the future.

TYPE OF MACHINERY	MANUFACTURER	MODEL NO.	NO. of MACHINES	SUPPORT or FACE
Cutting machine	Joy	15RU	3	F
Continuous miner	Lee Norse	HH455	1	F
Continuous miner	Jeffrey	120-H2	1	F
Coal drill	Long-Airdox	TDF-24	3	F
Roof bolter	Lee Norse	T1-43	2	F
Roof bolter	Galis	520	1	F
Shuttle car	Wagner	MTT-F20-S18	5	F
Front end loader	Eimco	915D	7	F
Front end loader	Eimco	915E	2	F
Feeder breaker	Stamler	14B	4	F
Feeder breaker	Long-Airdox	Roscoe II	1	F
Service vehicle	Sien	606T	2	S
Service vehicle	Sien	603	13	S
Service vehicle	Sien	620-E	1	S
Service vehicle	Sien	612-E	1	S
Service vehicle	Ford	4500	1	S
Service vehicle	International	2500	2	S
Compressor	Garden-Denver	185 CFM	1	S
Rock duster (hyd)	MSA	400	3	S

211.10C (6)vi

Site restoration is not an on-going reclamation process as in surface mining, but a one-time terminal phase. Consequently, this reclamation is not located as an integral part of operations with cost allocation, but rather an obligation which the company is committed to perform as contemporaneously as practical. Costs are not broken down per acre or by function (backfilling, grading, etc.) since the project will be done on a small scale with the same operator performing all functions at once. Overall cost of the site reclamation for grading and seeding is estimated at $2,000/acre. Cost of dismantling and removing structures will be reclaimed in salvage of the same.

Methods and Measures to Comply with Section 211.4 and 211.40
211.4D Control and Prevention of:

1. Soil erosion - Refer to Section 211.10C (6)iv on water diversion and Section 211.10C (6)iii A, C, D, and E on site restoration.

2. Air pollution - Refer to Section 211.10C (6)ix.

3. Surface or ground water pollution - Refer to Section 211.10C (6)xiii concerning hydrology; and Section 211.10C (6)xiv, compliance of NPDES permit.

4. Diminution of normal flow of water - Refer to Section 211.10C (6)iv concerning reclamation engineering techniques - control of water drainage; and Section 211.10C (6)xiv, plans for protecting resources.

5. Adverse impact on fish and wildlife - Minimized by prevention of air and water pollution above. Surface activities are curtailed

from November 1 through April 1, except in the portal areas, so as to not disturb wintering elk.

6. Permanent damage to vegetation, crops or timber - Refer to Section 211.10C (6)iii, on site reclamation.

7. Creation of unsafe or hazardous conditions - Refer to Section 211.10C (6)ii. In accordance with Federal Coal Mine Safety Act regulations, the operator strives to prevent the occurrence of unsafe or hazardous conditions. The mine Safety Department conducts safety programs which inform and teach safety principals and which are designed to instill attitudes and awareness in all employees conducive to creating safe working conditions. The Safety Department also inspects for such conditions and is responsible for seeing that unsafe conditions are corrected.

8. Damage to improvements - The only improvement on surface is a watering trough which is fed by a spring. Cutting an aquifier could dry up the spring. Should such occur, the company will provide an alternate water supply. Upon termination of mining and pumping water out of the mine, aquifiers should be restored naturally.

9. Damage to recretional, cultural, scientific, historical, archeological and paleontological values - Recreational (big game hunting) damage is minimized by No. 5 above. Archeological remains are present throughout the general area. Evidence from recent archeological investigations indicate they are sparce. Detailed information is lacking as to the extent and quality of

the sites in the lease area. Earth disturbing activities due to mining related activities other than subsidence, will obliterate cultural evidence where the two occur in the same site, and therefore they will require an inventory of each project to prevent loss of values.

A scientific study by the Forest Service covering about 40 acres is located on the lease. The study consists of contour trenching on Little Duncan Mountain and a fenced-off area at the base of the hill to evaluate the effects of contour trenching. Should subsidence occur, the study will be altered. The study could be extended to include the effects of subsidence.

10. Adverse impact on adjacent land uses - Underground mining will cause no adjacent land impact other than discharge water. Compliance with federal and state water regulations assures no negative impact.

1. Contemporaneous reclamation - Refer to Section 211.10C (6)iii, Nature and timing of surface reclamation.

2. Replacement of overburden - Not applicable.

3. Stabilization and protection of surface areas - Refer to Section 211.10C (6)iiia.

4. Saving and protection of topsoil - Not applicable.

5. Utilization of water - Refer to Section 211.10C (6)xiii.

6. Plugging auger holes - Not applicable.

7. Preservation of water quality, quantity and flow - Refer to Section 211.10C (6)xiv.

8. Disposition of rubbish and waste - Operations accumulate (at the most) five cubic yards of rubbish per day, consisting of rags, cardboard boxes and paper. Present practice in the construction phase is to dispose this refuse on the face of the fill and then cover it in the manner of a sanitary landfill. Plans are being made to change this practice in the operational phase to incorporate use of an incinerator located at the portal site or haul the refuse to a suitable landfill site. All plans will comply with the proper state and federal regulations.

9. Excavation, drilling or blasting operations will not come within 200 feet of an active or abandoned working without permission from the area mining supervisor.

10. Explosives - Use of explosives is in accordance with applicable state and federal laws.

11. Construction and removal access facilities - Refer to Section 211.10C (6)iii.

12. Construction of roads - Access road is constructed. There will be no additional road construction without federal approval.

13. Revegetation - Refer to Section 211.10C (6)iii.

14. Public access - Company does not normally restrict public access to surface except by warning signs at the mine-site and caution signs on the mine haulroad.

15. Fire prevention and control - Fire detection equipment, fire fighting equipment, an ambulance, a first-aid room, and mine rescue equipment are located on the site and in the mine where applicable.

16. Strip pit fire prevention - Not applicable.

17. Augering in strip pit - Not applicable.

Anticipated Starting and Termination Dates for Each Phase of the Mining Operation
211.10C (6)viii

See Map 1B.

Anticipated number of acres of land to be affected by each of the preceding two items:

First year	None
Second year	approximately 110 acres
Third year	approximately 200 acres
Fourth year	approximately 160 acres
Fifth year	approximately 240 acres
Sixth year	approximately 240 acres

Compliance Steps for Air Quality Control Laws and Regulations
211.10C (6)ix

Operator controls fugitive dust by application of water to areas where needed.

Compliance Steps for Water Quality Control Laws and Regulations
211.10C (6)ix

The operator discharges water into East Spring Canyon under authority of National Pollution Discharge Elimination System Permit No. UT0022918. This permit requires monthly sample monitoring of the mine water discharge and sets limits on parameters which are met. One point source discharge has been identified as the ancillary plant discharge. Sedimentation tank has been constructed to achieve compliance with the effluent limitations specified for this discharge.

Measures for Maximum Recovery of Mineral Resource
211.10C (6)x

Mine production to follow mine plan sequence designed to prevent a squeeze, bounce or other conditions that might discourage logical mining of the lease. The mine plan is designed to maximize the safe recovery of the coal resource.

Mining methods are such that with given equipment, Mining Enforcement and Safety Administration standards will be met. Efforts to improve recovery

keeping within safety standards will be constantly reviewed. Any improvement in mining equipment or methods will be studied and considered for use at this mine.

Method of Abandonment
211.10C (6)xi

After panel sections taken off of submain headings are complete, panels will be sealed according to the outline submitted and approved by the Mining Enforcement and Safety Administration.

Logs and Analyses of Overburden Samples
211.10C (6)xii

See following lithologic logs of 1976 drill holes.

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DATE Aug. 18, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-1-D

LOGGED BY Bucurel GROUND ELEV. 8310 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM TO , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	2	2'	Alluvian	Med. brown	
	2	22	20'	ss	Lt. reddish-brown, f. to m.g., friable, poor to mod. sorting, subrounded to subangular.	
	22	35	13'	ss	As above but lt. brown and lt. gry.	
	35	40	5'	ss	White, as above but mainly fine gr.	
	40	80	40'	ss	Lt. brn, occ. reddish, f. and m. and crs, and v. coarse grained - conglomeratic, subangular to subrounded, poor sorting.	
	80	100	20'	ss	Lt. brn, v.f. and f.g., sli. friable, angular, mod. sorting	
	100	103	3'	clayst.	Yellow brn. & gry, v. soft, carb.	
	103	120	17'	ss	Yellow brn. and dk. gry, v.f.g., v. silty, v. soft, carb.	
	120	147	27'	ss	Dk. gry, v.f.g., carb., med. hard to hard, poor sorting, coaly from 141' - 143' shows signs of weathering	
	147	162	15'	clayst.	Dk. gry & brn, v. soft, v. carb.	
	162	163	1'	ste	Med. gry, carb, hard	
	163	181	18'	ss	Dk gry, v.f.g., silty, v. carb, v. soft	
	181	187	6'	ss	Lt gry, v.f.g. to f. g., calc., hard	
	187	195	8'	ste	Dk gry, v. carb, soft, clayey	
	195	200	5'	clayst.	Dk gry, carb, soft, sli. silty	
	200	230	30'	clayst.	Dk gry, v. carb., m. hard, silty, ss interbed 203" - 204'	
	230	240	10'	ste	Lt to med gry, sli. carb., sandy, hard with yellow brn, f.g. sandstone interbeds, occ. clyst. interbed.	
	240	265	25'	ss	Lt-med. gry, v.f.g., hara, poor sorting, angular, silty with occ. clayst. interbeds	
	265	300	35'	ss	Lt gry & yellow brn, poor sorting, mod. porosity, weathered, hard & soft calc, sli. carb, with carb. claystone interbed 294-296 (weathered)	
	300	318	18'	ste	Med. gry, carb., sandy, hard, with clayst. interbeds - dk. gry, carb.	
	318	320	2'	ss	Lt. gry, v.f.g., calc, hard, poor sorting	
	320	340	20'	ss	Med. gry, v.f.g., carb., hard, calc. with ste and clayst. interbeds	

DATE Aug. 18, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-1-D

LOGGED BY Bucurel GROUND ELEV. 8310 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM TO , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	340	347	7'	ste	Med. gry, carb, hard, with silty carb. claystone interbeds	
	347	363	16'	ss	Lt. gry, v.f.g., hard, calc.	
	363	379	16'	ss	Med. gry, v.f.g., silty, carb., hard	
	379	380	1'	ss	Med. gry and brn, f.g., carb, soft	
	380	390	10'	ste	Med. gry, med. hard, sli. carb., 1.0' coal 388' - 389'	
	390	418	28'	ss	Lt gry, v.f. & f.g., v. hard, poor sorting	
	418	475	57'	ss	Lt gry & Lt brn, f.g. & v.f.g., m. hard & v.hard, coal interbed 423-424' (?) interbeds	
	475	498	23'	ste	Lt gry, calc, sandy, hard, occ. clayed interbeds	
	498	502	4'	clayst.	Dk gry, carb, soft	
	502	518	16'	ss	Lt gry, v.f.g., calc, hard, occ. brn and dk gry carb, clayed interbeds	
	518	550	32'	ste	Med gry, calc, hard, sli carb, with yellow ss interbeds, occ. claystone interbeds	
	550	580	30'	ss	Lt gry, v.f.g., calc, hard	
	580	720			Lost circulation, no return	
	720	780	60'	ss	Lt gry, v.f.g - fig., calc, hard, coal, around 760'	
	780	820			No return	
	820	850	30'	ss	As above with ste interbeds	

Upper Hiawatha coal seam encountered at 850'.

DATE July 24, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-36-E

LOGGED BY Larry Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 120 , WATER FROM 120 TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	10	10	Soil	Med. dk. grey	
	10	20	10	Gravel		
	20	40	20	S.S.	Med. grey, fn.gr. well sorted subrangular, sub-rounded, manily qtz, some chert & fsp.	
	40	60	20	Siltstone	Med. grey, slightly moist.	
	60	70	10	S.S.	Med. grey, fn.gr. well sorted, subrangular, sub-rounded, mainly qtz, some chert & fsp.	
	70	90	20	S.S.	As above but slightly moist.	
	90	100	10	Shale	Med. dk. grey.	
	100	120	20	Siltstone	Brownish grey.	
	120	147	27	"	Greyish brown.	
	147	157	10	Congl.S.S.	Sand as above, max. pebble size 1/8"	
	157	165	8	Siltstone	Brownish grey.	
	165	170	5	Congl.S.S.		
	170	200	30	Congl.	Pebbles approaching 1/4", clayish matrix Pebbles - shale & qtz.	
	200	210	10	Siltstone	Brownish grey, with med. grey shale/siltstone frags	
	210	235	25	"	As above, with some sand & shale frags, probably interbedded	
	235	240	5	N/R	Missing	
	240	250	10	Siltstone	Interbedded siltstone with some shale & sandstone	
	250	260	10	Siltstone	Interbedded siltstone & shale.	
	260	275	15	Shale	Dark brownish black shale.	
	275	280	5	Shale	Dark brownish black shale with some siltstone	
	280	300	20	Shale	Med. dark grey shale	
	300	315	15	Shale	Med. dark grey shale; coal frag.	
	315	330	15	Shale	Med. grey shale, sandstone frag. (interbedded), coal frags.	
	330	340	10	Shale/S.S.	Interbedded grey shale; fn. gr. orange ss, well sorted subangular to subrounded	
	340	420	80	Shale & S.S.	As above with coal frags & siltstone partings - coal frags decreasing with depth.	

DATE July 24, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-36-E

LOGGED BY Larry Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 120 , WATER FROM 120 TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	420	430	10	Shale	Dark greyish black, v. carb. in part, coal frags.	
	430	450	20	Shale	Interbedded drk greyish black and medium grey shale, coal frags	
	450	455	5	Shale	As above, with numerous coal frags.	
	455	480	25	Shale & S.S.	Interbedded dk. greyish black and medium grey shale coal frags; med. grey fn.gr. subrounded well sorted sandstone interbeds	
	480	500	20	Shale	Dk. greyish black shale; with S.S. interbeds; siltstone partings; coal fragments.	
	500	510	10	Shale	Med. grey shale, sandstone partings, coal frags.	
	510	525	15	Shale	Dk. brownish black carb. shale with siltstone partings, sandstone frags (prob. interbedded).	
	525	545	20	Shale & S.S.	Dk. grey shale interbedded with med. orange brn. fn.gr. sandstone, well sorted, subangular -sub-rounded; mainly qtz, some chert; siltstone partings coal frags., also med. grey v. fn.gr. well sorted, rounded S.S.	
	545	560	15	Shale	Dk. grey shale, S.S. partings, coal frags and med. grey v. fr.gr. well sorted, rounded S.S., siltstone partings.	
	560	595	55	Shale & S.S.	Dk. grey shale, interbedded with fr.gr. S.S. (as above), coal frags, siltstone partings, also med grey v. fn.gr. S.S.	
	595	610	15	Shale & S.S.	Dk. grey shale interbedded with med. grey v.fn.gr. sandstone;coal, carb. shale, siltstone frags.	
	610	635	25	Shale & S.S.	Dk. grey shale; med. grey v.fn.gr. ss; orange brown fn.gr.ss interbedds, frags of carb. shale, siltstone & coal.	
	635	640	5	Shale & S.S.	Dk. grey shale, med. grey v.fn.gr.ss; green-grey siltstone interbeds; carb. shale frags.	
	640	645	5	Shale & S.S.	Interbeds of dk.grey shale; med. grey v.fn.gr.ss; orange-brown frags ss; greenish grey siltstone.	
	645	650	5	Shale & S.S.	Interbedded dk. grey shale; dk. brown carb. shale; v.fn.gr. med. grey ss; fn gr. orange-brown ss; med. gr. white with pink tint subangular-subrounded well sorted -100% qtz ss; green-grey siltstone.	
	650	675	25	Shale & S.S.	Dk.grey shale, carb. in part; med grey, v.fn.gr. ss; fn.gr. orange-brown ss; dk. brown siltstone; coal frags.	
	675	705	30	Shale, Siltstone & S.S.	Dk. grey shale, carb. in part; med. grey v.fn.gr. grey ss; green-grey stiltstone interbeds; coal frags.	

DATE July 24, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-30-L

LOGGED BY Larry Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 120 , WATER FROM 120 TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	705	710	5	Shale & S.S.	Med. grey shale, carb. in part; v.fn.gr. well sorted, rounded sandstone, siltstone partings.	
	710	740	30	Shale & S.S.	Dk. grey shale; med. grey v.fn.gr. ss; orange-brown frag ss; siltstone partings; numerous coal frags.	
	740	750	10	Shale & S.S.	As above, with number of coal frags decreasing downward.	
	750	760	10	Siltstone & S.S.	Dk. brown-grey siltstone; med. grey v.fn.gr. ss; green-grey siltstone partings; coal frags	
	760	770	10	Shale & S.S.	Dk. grey shale; med grey v.fn.gr. ss; orange-brown, fn.gr.ss; coal frags.	
	770	780	10	N/R	Missing	
	780	785	5	Shale & S.S.	Dk. grey shale; med. grey, v.fn.gr.ss; orange-brown fn.gr.ss; coal frags.	
	785	790	5	Shale & S.S.	As above with greenish grey siltstone.	
	790	795	5	Siltstone	Med.dk. grey siltstone; poor return.	
	795	800	5	Shale & S.S.	Dk. grey shale; v.fn.gr.med.grey ss; orange-brown fn.gr. ss; siltstone; numerous coal frags.	
	800	820	20	Shale & S.S.	As above, some coal frags.	
	820	825	5	Shale & S.S.	Med. grey, v.fn.gr., well sorted, rounded ss; Med. dk. grey-black shale	
	825	840	15	N/R	Missing, lost circulation	
	840	845	5	Shale & S.S.	Dk. grey shale; med.grey, v.fn.gr. ss; orange-brown fn.gr.ss; siltstone & coal frags.	
	845	1000	155	N/R	Missing, lost circulation	
	Upper Hiawatha coal seam encountered at 1,000'.					

DATE July 26, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-6-F

LOGGED BY Larry Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 160 , WATER FROM 160 TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	14	14	Soil	Alluvium	
	14	60	46	Sandstone	Light orange-white; fn.gr. (.010"), well sorted, subrounded, mainly qtz; med. orange-white in part	
	60	75	15	"	Med. orange, fn.gr. well sorted, subrounded; light orange-white in part	
	75	80	5	"	Light orange-white, fn.gr., well sorted, sub angular - subrounded.	
	80	85	5	"	Light buff, fn.gr. well sorted, sub angular - subrounded, mainly qtz.	
	85	112	27	"	Light reddish white, fn.gr., well sorted, sub angular - subrounded	
	112	130	18	"	Light buff, fn. med. gr. (.020"), mod. sorting, subangular - subrounded.	
	130	145	15	"	Light orange-white, fn.gr. well sorted, subrounded.	
	145	160	15	"	Light buff-white, fn.gr., well sorted, subangular subrounded.	
	160	220	60	Conglomerate	Med. dk. brown consisted of shale, siltstone, s.s. pebbles (max. 1/2"); matrix of mud & fn.gr. s.s.	
	220	278	58	Siltstone & Sandstone	Interbeds of med.drk. brown siltstone; and med.grey, v.fn.-fn.gr., well sorted, sub rounded s.s.	
	278	380	102	Shale & Siltstone	Dk. grey-black shale; interbedded dk.brown siltstone and med. grey, v.fn.-fn.gr. well sorted s.s.	
	380	400	20	Shale & Siltstone	As above, coal frags.	
	400	415	15	"	As above, carb. partings.	
	415	460	45	Shale	Predominantly dk. grey shale; interbedded with siltstone and med.grey, v.fn.-fn.gr. s.s., carb. partings	
	460	465	5	"	As above; numerous coal frags.	
	465	475	10	"	Dk. grey shale; siltstone; med.grey, v.fn.-fn.gr. s.s.; carb. partings; coal frags	
	475	480	5	S.S;Shale Siltstone	Interbedded dk. grey shale; med.grey v.fn.-fn. gr. s.s.; dk. brown siltstone; orange fn.-med. fr. s.s.; carb. partings in siltstone	
	480	560	80	Shale	Dk. grey shale; med.-dk.grey, v.fn.-fn.gr. s.s.; dk. brown siltstone; carb. partings; coal frags	
	560	615	55	Sandstone Siltstone	Med.grey, v.fn.gr., well sorted, rounded s.s.; dk.brown carb. siltstone; orange-brown fn.gr. well sorted s.s.; occasional coal frags; dk. grey shale partings	

DATE July 28, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-6-F

LOGGED BY Larry Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 160 , WATER FROM 160 TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	615	695	80	Shale, S.S. & Siltstone	Interbedded dk.grey shale; med. grey v. fn.gr. s.s.; dk. brown siltstone.	
	695	753	58	"	As above, fn.med.gr., orange-brown s.s., coal frags	
	753	810	57	Shale, Siltstone, S.S. & Coal	Interbedded dk.grey shale, v.fn.gr., med.grey s.s.; siltstone; orange-brown, fn.gr.s.s. partings; v. abundant coal frags	
	810	820	20	"	As above, with black shale, v. abundant coal frags	
	820	835	15	"	As above, less black shale; v. abundant coal frags	
	835	865	30	Sandstone & Shale	Interbedded fn.-med.gr., orange-brown s.s.; black shale; v.fn.gr., med-grey s.s.; siltstone partings; abundant coal frags	
	865	875	10	Missing	Missing	
	875	880	5	Sandstone & Shale	Interbedded fn.-med.gr., orange-brown s.s.; black shale; v.fn.gr., med-grey s.s.; siltstone partings; abundant coal frags	

Upper Hiawatha coal seam encountered at 880'.

DATE August 16, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-31-G

LOGGED BY Nicoll GROUND ELEV. 8450 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 200 , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	10	10	Alluvium	Med.-dk. brown	
	10	20	10	Poorly Lithified	Dirt, sand; yellowish brown in color	
	20	40	20	" "	Sandy; med. grey	
	40	60	20	Sandstn & Siltst	Interbedded light grey, fn.gr., sandstn; light med. grey, soft silty	
	60	80	20	Sandstn	Med. grey, fn.-med. gr., mod. sorting, angl.-sub angl; silty	
	80	120	40	Sandstn	White, fn.gr., well sorted, sub angl-sub rounded, reddish white in part	
	120	140	20	Sandstn	as above, with sandstn and siltstn pebbels (¼")	
	140	160	20	Sandstn	White, fn.gr., well sorted, sub angl.-sub rounded, reddish white in part	
	160	200	40	Sandstn	As above, with pebbles (1/8")	
	200	240	40	Conglom. Sandstn	Buff white, fn.-med. gr. sandstn, with brown siltstn & sandstn pebbles (1/8" - ¼")	
	240	255	15	Shale & Silstn	Interbedded dk. grey shale; brownish siltstn; buff, fn.-med. gr., sandstone	
				Sandstn		
	255	260	5	" "	As above, pebbles (1/8")	
	260	280	20	" "	Same as 240'-255'	
	280	295	15	" "	As above with orangish white, med.gr. sandstn	
	295	300	5	Sandstn	Med. gr., fn.gr., well sorted, sub rounded; dk. brown carb. siltstn partings	
	300	360	60	Sandstn & Shale	Dk. brownish grey shale; coal frags.; med. grey, fn.gr., well sorted sandstn, dk. brown slightly carb. siltstn	
	360	365	5	Shale	Dk. grey and med. grey; hard	
	365	460	95	Shale & Sandstn	Shale, as above; with mod. grey, fn.gr. sandstone; dk. brown, slightly carb. siltstn partings	
	460	465	5	" "	Med. & dk. grey shale; med.-dk. brown siltstn med. grey, fn.gr. sandstone	
	465	490	25	Shale, Siltstn & Sandstn	Med. & dk. grey shale; med.-dk. brown siltstone med. grey, fn.gr. sandstn	
	490	495	5	Shale & Sandstn	Med. dk. brownish grey shale; coal frags.; med. grey, fn.gr. sandstn; dk. brown carb. siltstn partings	

DATE August 16, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-31-G

LOGGED BY Nicoll GROUND ELEV. 8450 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 200 , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	495	815	320	Shale Siltstn & Sandstn	Med. & dk. grey shale; dk. brown, v. carb. siltstn; med. grey, fn.gr. sandstone	
	815	820	5	" "	As above, coal frags.	
	820	860	40	" "	Same as 495'-815'	
	860	880	20	Sandstn	Med. gr., fn. gr. well sorted, subrounded; with shale and siltstn partings	
	880	980	100	Siltstn Sandstn & Sandst	Same as 820'-860'	

PAGE OF HOLE NO. 76-31-G

Coastal 833 (9/74)

Upper Hiawatha coal seam encountered at 980'.

DATE July 28, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-31-H

LOGGED BY L. Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier Co., Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 220 , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	38	38	soil & allurium		
	38	45	7	sandst	Orangish br., v.f. gr., well sorted, subang. - subrounded; siltst partings	
	45	140	95	sandst	Med. - light grey, v.f. gr., well sorted, subrounded	
	140	280	140	sandst.	White, v.f. gr., well sorted, subrounded	
	280	315	35	N/R	No Return	
	315	320	5	sandst.	light br., v.f. gr., well sorted, subrounded	
	320	330	10	sandst.	White, v.f. gr., well sorted, subrounded	
	330	335	5	N/R	No Return	
	335	340	5	sandst.	Light br., v.f. gr., well sorted, subrounded	
	340	350	10	N/R	No Return	
	350	355	5	sandst.	White, v.f. gr.	
	355	360	5	shale & sandst.	Interbdd f. gr. grey sand tkd. gy. shale	
	360	375	15	N/R	No Return	
	375	380	5	sandst.	Lt. orangish br., v.f. gr., well sorted; siltst. partings	
	380	395	15	N/R	No Return	
	395	400	5	shale	Dk. greyish black	
	400	415	15	N/R	No Return	
	415	420	5	sandst. & shale	Interbedded v.f. gr. grey ss. dk. grey shale	
	420	455	35	N/R	No Return	
	455	460	5	sandst.	Med.-light grey; f. gr., well sorted, subang. - subrounded	
	460	475	15	N/R	No Return	

DATE July 28, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-31-H

LOGGED BY L. Nicoll GROUND ELEV. PROJECT SUFCo

LOCATION Sevier Co., Utah WEATHER

CIRCULATION WITH: AIR FROM TO , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	475	500	25	shale & sltst	Interbedded dk. br. siltstone, dk. grey shale	
	500	535	35	N/R	No Return	
	535	540	5	shale & sltst	Interbedded dk. br. siltstone, dk. gy. shale	
	540	600	60	N/R	No Return	
	600	615	15	sltst.	Med. grey (Poor return)	
	615	625	10	sltst.	Light brown	
	625	640	15	sltst.	Med. grey (Poor return)	
	640	660	20	N/R	No Return	
	660	700	40	sltst.	Med. br. (Poor return)	
	700	880	180	sltst, sandst., & shale	Interbedded med. grey siltstone, greenish grey siltstone, f. gr. med. grey sandst, orangish-brown sandst., dk. br. siltst, dk, grey shale	
	880	900	20	N/R	No Return	
	900	1090	190	sltst, sandst., & shale	As 700' - 880'	

Upper Hiawatha coal seam encountered at 1,090'.

DATE August 14, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-32-I

LOGGED BY Nicoll GROUND ELEV. 8500 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM TO , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	30	30		Alluvium	
	30	40	10	Sandstn	Light orangish brown, v.fn.gr., well sorted, subrounded	
	40	60	20	Sandstn	Light grey, v.fn.gr., well sorted, rounded	
	60	120	60	Sandstn	White with orangish partings, fn.-med. gr., well sorted, subangl.-subrounded	
	120	150	30	Sandstn	As above, with some pebbles (1/16")	
	150	180	30	Sandstn	Med. orangish grey, fn.-cse.gr., mod. sorting subangular, max. pebble size 1/8"	
	180	200	20	Sandstn	Buff-white, fn.-med. gr., well sorted, subangl.-subrounded	
	200	210	10	Sandstn	As above, with pebbles (1/16")	
	210	262	52	Conglo-merate	Consists of brown siltstn, grey sandstn pebbles (max size 1/2"); sandstn matrix, siltstn increasing downwards	
	262	360	98	Shale & Siltstn & Sandstn	Interbedded med. brown shale; dk. brown siltstn, carb. in part; med. grey, fn.gr. well sorted sandstn	
	360	480	120	Shale & Siltstn & Sandstn	Dk. grey shale; brown shale with carb. fragments; carb. siltstn; med. grey fn.gr. sandstn. INTERBEDDED	
	480	490	10	Mudstn	Yellowish brown mudstn; grey shale; med. grey, fn.gr. sandstn	
	490	520	30	Shale, Siltstn & Sandstn	Grey shale; carb. brown siltstn; med. grey fn.gr. sandstn; brown shale with carb. partings	
	520	540	20	Shale	Black and grey shale; coal fragments	
	540	785	245	Shale, Siltstn & Sandstn	Grey and black shales; siltstn; med. grey, fn. gr. sandstn interbeds	
	785	810	25	Sandstn	Med. grey, fn.gr., well sorted, subangular-subrounded	
	810	860	50	Shale, Siltstn & Sandstn	Same as 540'-785'	

DATE August 14, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-32-I

LOGGED BY Nicoll GROUND ELEV. 8500 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM TO WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	860	905	45	Silstn	Brownish grey siltstn and shale,	
				& Shale	Calcareous	
	905	970	65	Shale Siltstn	Same as 810'-860'	
				& Sandstn		

PAGE OF HOLE NO. 76-32-I

Coastal 833 (9/74)

Upper Hiawatha coal seam encountered at 970'.

DATE August 11, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-32-J

LOGGED BY Nicoll, Bucurel GROUND ELEV. 8460 PROJECT SUFCo

LOCATION Sevier County, Utah WEATHER

CIRCULATION WITH: AIR FROM 0 TO 240 , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	15	15	Sandstone	Orangish brown, med. grained, mod. sorting, sub angular	
	15	40	25	"	Buff, fn.gr. (.010"), well sorted, sub. rounded mainly qtz	
	40	50	10	"	Orangish, fn. gr., well sorted, sub rounded	
	50	120	70	"	Buff-white, fn.gr. well sorted, sub rounded	
	120	160	40	"	Light grey, med. grain, well sorted, sub rounded	
	160	220	60	"	Orangish white, med. gr., well sorted, sub angular - subrounded	
	220	240	20	"	Buff-white, fn.gr., well sorted, sub rounded	
	240	760	520	Sandstn, Shale &	Interbedded dk. greyish block shale; light grey well sorted sandstn; orangish brown, fn.gr., well	
				Silstn	sorted sandstn; siltstn in part	
	760	775	15		Missing	
	775	780	5	Sandstn	As above	
				Shale & Siltstn		
	780	800	20		Missing	
	800	820	20	Sandstn	Dk. greyish black shale; light grey, well sorted sandstn, grey siltstn, dk. brown carb. siltstn	
				& Shale		
	820	945	125	Shale & Sandstn	Med. grey shale, med. grey, fn.-med. gr., sub-angl.-subrounded sandstn, dk. brown carb. siltstn;	
					& med. grey siltstn.	

Upper Hiawatha coal seam encountered at 945'.

DATE August 8, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-28-K

LOGGED BY Hildred Bucurel GROUND ELEV. 8480' PROJECT SUFCo

LOCATION Salina WEATHER

CIRCULATION WITH: AIR FROM ____ TO ____, WATER FROM ____ TO ____

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	0	25'	25'	SS	white, f.g. to m.g., sugary, subangular and sub-rounded, moderate sorting	
	25'	60'	35'	SS	light gray, f.g., occ. med. gr., subangular mod. sorting, with occ. lt. brown layers	
	60'	85'	25'	SS	white, f.g. and m.g., sugary	
	85'	140'	65'	SS	white, light brn interbeds, f.g., occ. m.g., subangular to subrounded, mod. sorting	
	140'	170'	30'	SS	lt. brn., f.g. to m.g., subrounded, mod. sorting	
	170'	180'	10'	SS	white, f.g. to m.g., subrounded, mod. sorting	
	180'	200'	20'	SS	lt. gry., v.f.g., angular, poor to mod. sorting, occ. chert (?) fragments, last 3' is carbonaceous	
	200'	211'	11'	Ste	dk. gry., carb., calc., mod. hard, v. sandy	
	211'	244'	33'	SS	dk. gry, silty, carb., v. f.g., cal., hard, angular	
	244'	246'	2'	SS	lt. gry., v.f.g., calc., angular, sli. carb.	
	246'	250'	4'	SS	dk. gry., v.f.g., carb., calc.	
	250'	257'	7'	SS	lt. gry., v.f.g., calc. sli. carb., angular, mod. porosity	
	257'	261'	4'	Ste	dk. gry., v. carb., sli. calc., sandy, low porosity	
	261'	263'	2'	SS	as above	
	263'	279'	16'	SS	dk. gry., v.f.g., silty, v. carb., hard, low porosity, poor sorting, occ. coal streaks	
	279'	294'	15'	Ste	dk. gry., clayey, carb., calc.	
	294'	296'	2'	SS	lt. gry and lt. brown, v.f.g., m. hard, mod. sorting, mod. porosity, sli. carb.	
	296'	301'	5'	Ste	dk. gry., carb., calc.	
	301'	303'	2'	SS	lt. gry., v.f.g., silty, sli. calc., mod. porosity, poor sorting	
	303'	320'	17'	SS	lt. gry & lt. brn., v.f.g., subangular, mod. sorting, hard, calc.	
	320'	362'	42'	SS	lt. gry., v.f.g., silty, v. sli. carb., calc. subangular with thin ste interbeds	
	362'	365'	3'	Shale	Dk gry. to bk., v. carb., sli. silty, soft	
	365'	378'	13'	SS	lt. gty., v.f.g., silty, hard, poor to mod. sorting, calc.	
	378'	415'	37'	Ste	dk. gry., hard, carb., calc., occ. thin v.f.g., lt. gry, sandstone interbeds, and occ. thin coal laminae	

DATE August 8, 1976 COASTAL STATES ENERGY CO. HOLE NO. 76-28-K

LOGGED BY H. Bucurel GROUND ELEV. 8480' PROJECT SUFCo

LOCATION WEATHER

CIRCULATION WITH: AIR FROM TO , WATER FROM TO

CORE BOX NO.	DEPTH FROM	DEPTH TO	THICKNESS OF STRATUM	FORMATION (KIND ROCK)	DESCRIPTION & REMARKS	STRIP LOG
	415'	463'	48'	SS	lt. gry., v.f.g., v. calc. m. hard to hard, low porosity, poor sorting	
	463'	502'	39'	Ste	med. gry., sandy, carb., hard, with soft shale interbeds that are very carb.	
	502'	622'	120'	SS	lt. gry., silty, v.f.g., hard, calc., with occ. shale and ste interbeds	
	622'	624'	2'	Ste	dk. gry, sandy, m. hard, numerous coal and carb. shale interbeds	
	624'	637'	13'	SS	as above	
	637'	639'	2'	Ste	dk. gry, sandy, m. hard, numerous claystone interbeds	
	639'	740'	101'	SS	lt gry., v.f.g., silty, hard, calc., becoming more silty toward bottom	
	740'	790'	50'	Ste	dk. gry, hard, calc., with soft v.f.g. SS and shale interbeds, coal interbed 774'-775', small coal interbeds 780'-790'	
	790'	800'	10'	Ste	dk gry, hard, calc. with soft v.f.g. SS interbeds	
	800'	860'	60'	Ste	dk gry, hard, calc., with SS interbeds and numerous carb., black coal, shale interbeds	
	860'	880'	20'	SS	lt gry, v.f.g., v. calc., med. hard, sli. carb., poor sorting, with Ste and shale interbeds	
	880'	889'	9'	Clayst.	dk. gry, silty, carb., ste interbeds	
	889'	898'	9'	SS	lt gry, v.f.g., v. calc., med. hard, sli. carb. poor sorting	
	898'	915'	17'	Clayst.	dk. gry, silty, carb., ste interbeds	

Upper Hiawatha coal seam encountered at 915'.

HYDROLOGY

211.10C (6) xiii

GENERAL

Water is encountered as seeps in faults in the underground workings of the SUFCo Mine. The workings were dry until June, 1974, when the first water was encountered. This water has been allowed to flow into and collect in old abandoned workings. For reasons of mine safety, this flow is now pumped out of the mine and into East Spring Canyon.

East Spring Canyon is an intermittent tributary of the Quitchupah Creek watershed, a minor subcatchment of the Colorado River Basin (Plate 3).

One-half mile south of the mine portal, East Spring Canyon joins with Convulsion Canyon, which is drained by Quitchupah Creek. Quitchupah Creek merges with Ivie Creek about 13 miles southeast of the mine and then empties into Muddy Creek two miles further downstream. The waters of Muddy Creek ultimately flow into the Colorado River about 96 air miles southeast of the mine. Above its confluence with Ivie Creek, the Quitchupah watershed encompasses about 125 square miles. The catchment area is somewhat triangular in shape and extends from the Ivie Creek confluence to the Colorado River divide in the higher elevations to the west.

The average annual precipitation for this area varies from 8 inches in the lowlands near Emery to about 25 inches at the mine. Monthly average precipitation varies from 0.5 inch to slightly over one inch (Ref. 1).

The composition of surficial soils in the catchment area have been discussed in previous sections of this report. Permeabilities of the soils vary from almost zero for the exposed rock to moderate for the alluvial soils. Moderate permeabilities are defined as 0.6 to 2.0 inches per hour by the Soil Conservation Service (Ref. 4).

GROUND WATER

Reconnaissance of the ground water regime indicates there is a surface spring located at the juncture of East Spring Canyon and Convulsion Canyon. This spring is known as Mud Spring. SUFCo has an appropriation of 0.50 cfs from this spring and is using it as a source of culinary water at the mine. A second spring was located in East Spring Canyon, a short distance upstream from the mine portal, but no longer flows and may be related to the seepage in the mine. No historical records are available for the flows, but according to the miners (Ref. 5) familiar with the area, the flow above Mud Spring was intermittent and largely dependent upon precipitation rather than the spring flow. However, the persistent low flow in Convulsion Canyon is due to the presence of Mud Spring.

Underground, faults in the N 15° W structural trend yield seeps of ground water. The first, or East Spring, was encountered in the No. 2 East Entries about 8,800 feet from the portal and is shown in Plate 2. The second, or West Spring, was encountered in the No. 1 West Entries about 9,100 feet from the portal as shown in Plate 2. The East Spring is estimated to have a flow of about 15 gpm and the West Spring about 12 gpm.

The rate of flow from the fault seeps was initially higher when first penetrated by the underground drift, and have now subsided to some extent. No

attempt was made to measure the initial flows as the water was simply collected in sumps and pumped into the old underground workings. This water is now discharged into East Spring Canyon because if this water were allowed to fill the old workings, the ventilation route through the mine would be cut off and the mine could not be operated safely.

Overall consideration of the probable ground water flow patterns indicates that water is probably contained in the overlying sandstone members of the Price River Formation, particularly the basal Castlegate Sandstone, and in the sandstone members of the Blackhawk Formation which overlie the Upper Ivie Coal Seam. Despite the presence of aquifers above the workings, the mine has remained essentially dry because the sandstone sequence contains several shale and silt members and partings which serve as aquicludes to retard the vertical percolation of the ground water and to form perched aquifers above the coal. A particularly effective seal is obtained by a 20-foot thick stratum of bluish-gray bentonitic shale which directly overlies the producing coal seam. As these sandstone members crop out on the sides of the cliffs and along the slopes of the canyons they would normally be drained by horizontal percolation downdip and along the strike of the sandstone beds until released by slow seepage to the surface and lost through evapotranspiration or by release into the surface water regime.

The minor faulting which was encountered in the mine has breached the integrity of the aquicludes and allows vertical percolation into the mine workings below.

It may be expected that as future workings are advanced towards the northwest, similar faults and related seeps will be encountered and that flows

from such structures will be any added to those already encountered. Observation of the seepage indicates that initial high flows along the faults diminish with time as the stored water is depleted. Because new flows may be expected to be encountered, the total flow is variable and accurate projections of future flow cannot be made at this time.

SURFACE HYDROLOGY

The flow of surface water in East Spring Canyon and in Quitchupah Creek is known to be intermittent in nature and largely dependent upon factors of snowpack in the higher mountains of the Wasatch Plateau, the timing of the advent of warm weather in the spring and early summer, and the intensity of precipitation during that same period. The stream beds of East Spring Canyon and of Convulsion Canyon west of Mud Springs have been commonly noted to be dry in the summer and fall months (Ref. 5). Downstream from Mud Springs, however, the flow of Quitchupah Creek reflects the discharge from Mud Springs and seldom runs dry for this reason. Quitchupah Creek would otherwise be dry during periods of low runoff. The U.S. Soil Conservation Service advises that Quitchupah Creek has been observed on several occasions to be dry downstream as far as Utah State Highway 10 (Ref. 6).

Vegetation in the Quitchupah drainage varies from scattered grass and occasional sagebrush in the lowlands to cultivated land near Interstate Highway 10 south of Emery and some mountain aspen and conifers in the higher elevations. Mountain meadows containing grasses, forbs, and a few shrubs also exist in the upper Quitchupah watershed.

The lands under cultivation must receive irrigation water to be

productive. Some of the agricultural water supply for the cultivated lands is diverted from Quitchupah Creek. However, the flow from this creek is not dependable and the irrigation supply is supplemented via the Emery Canal with water from Muddy Creek (Ref. 6).

Nevertheless, Quitchupah Creek is ungauged, has no historical flow data, and therefore, the history and characteristics of flow are unknown.

An approximation of the character of flow in Quitchupah Creek may be synthesized by comparision with known data from the similar watershed of Muddy Creek which is the next drainage to the north. The only flow gauges in the area are both located on Muddy Creek (Refs. 7 and 8).

Flow gage 9-3305 is located on Muddy Creek five miles north of Emery in the NE¼ of Section 16, T. 21 S., R. 6 E. The period of record is April to July, 1909; July, 1910 to July, 1914; and June, 1949 to the present. The drainage area of Muddy Creek above this gage is 105 square miles. The area of drainage of Muddy Creek above gage 9-3321, including the headwaters above gage 9-3305, is 418 square miles. For the 28 years of historical record, the average flow rate was 37.8 cubic feet per second which provided an average discharge of 27,390 acre-feet per year. The maximum flow rate of record was 3,340 cfs on May 10, 1952 and the minimum was no flow for the period April 13 to 16, 1911 (Ref. 8).

Flow gage 9-3321 is located downstream from a bridge on Interstate Highway I-70, 0.5 miles downstream from the confluence with Ivie Creek and about eight miles southeast of Emery. This gage was placed in operation so that published data is available only for the water year October, 1973 to September, 1974. For this year, the mean flow rate was 13.8 cfs, which provided a discharge of

10,020 acre-feet. The maximum flow was 176 cfs and the minimum was 2.2 cfs (Ref. 8). This data is insufficient to characterize the flow of Quitchupah Creek.

As their upper basins are very similar in the character of their elevation, topography, soils and vegetation, it may be reasonably assumed that the hydrological characteristics of Quitchupah Creek can be extrapolated from the historic flow data from Muddy Creek at gage 9-3305. Similar comparison of flows at gage 9-3305 and gage 9-3321 is not useful because of consumptive use of water in the agricultural community surrounding Emery and to differences in soil moistures and evapotranspiration losses between the upper and lower reaches of the drainage basins.

The drainage area of the East Spring Canyon above the mine is about eight square miles. The drainage area of the Quitchupah Creek in Convulsion Canyon above its juncture with East Spring Canyon is 14 square miles. The total of the two areas is about 22 square miles. The total Quitchupah drainage above the confluence with Ivie Creek is 125 square miles.

The flow characteristics of Muddy Creek above gage 9-3305 are best shown in a series of tables. Table 1 shows Peak Discharges of record. Table 2 shows Highest Mean Discharges by various duration periods. Table 3 shows Mean Monthly Flows for the period of record. Table 4 shows Lowest Mean Discharges by various duration periods. The salient features of these flows and the estimated equivalents for flows in Quitchupah Creek below the SUFCo Mine are shown on Table 5.

The character of the flow in Muddy Creek at gage 9-3305, and as assumed for Quitchupah Creek, is shown on Table 3 by the Monthly Mean Flow Rates

TABLE 1

PEAK DISCHARGES OF
MUDDY CREEK NEAR EMERY, UTAH
(Gage 9-3305)

Drainage Area = 105 Sq. Miles

Water Year	Date	Peak Discharge (cfs)	Water Year	Date	Peak Discharge (cfs)
1909	Jun 4, 1909	356	1957	Jun 6, 1957	403
1910	Jul 29, 1910	340	1958	Apr 18, 1958	660
1911	Aug 21, 1911	404		May 23, 1958	406
1912	Jul 28, 1912	446	1959	Apr 2, 1959	72
1913	Jul 8, 1913	969		Jun 21, 1959	52
1914	Jul 17, 1914	850	1960	Jul 29, 1960	282
				May 12, 1960	212
			1961	Aug 2, 1961	504
			1962	May 6, 1962	299
1949	Aug 8, 1949	816	1963	Sep 6, 1963	1,560
1950	Aug 11, 1950	360	1964	Jul 13, 1964	1,640
	May 29, 1950	192	1965	Jul 26, 1965	535
1951	Aug 3, 1951	1,120	1966	Aug 1, 1966	257
	May 24, 1951	116	1967	Jul 15, 1967	1,320
1952	May 10, 1952	3,340	1968	Aug 2, 1968	230
1953	Aug 28, 1953	1,560	1969	Jul 25, 1969	698
	Jun 12, 1953	173	1970	Aug 29, 1970	1,080
1954	Jul 18, 1954	2,120	1971		
1955	Aug 17, 1955	2,290	1972	Oct 24, 1971	295
1956	Jul 30, 1956	270	1973	Aug 6, 1973	544
	May 29, 1956	192	1974	May 9, 1974	268

References 7, 8, 9, and 10 Records of the USGS.

TABLE 2

HIGHEST MEAN DISCHARGE OF MUDDY CREEK AT STATION NUMBER 09330500
IN CSF
FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	183	ANNUAL
1911	404.0	260.0	209.0	182.0	174.0	155.0	139.0	128.0	96.1	54.7
1912	446.0	294.0	289.0	257.0	225.0	173.0	148.0	126.0	97.4	51.8
1913	446.0	247.0	234.0	210.0	193.0	156.0	129.0	113.0	85.9	49.0
1950	104.0	103.0	102.0	99.2	90.0	76.1	65.7	57.2	43.8	27.5
1951	200.0	184.0	165.0	139.0	124.0	103.0	88.2	76.6	57.7	34.7
1952	515.0	457.0	434.0	380.0	327.0	310.0	256.0	212.0	152.0	81.3
1953	146.0	128.0	125.0	120.0	107.0	90.8	77.8	66.5	49.5	32.9
1954	190.0	82.7	67.4	62.2	56.3	47.7	42.6	37.1	29.5	20.0
1955	132.0	86.7	79.7	72.3	67.4	61.4	51.6	44.1	32.9	20.0
1956	105.0	103.0	101.0	99.1	92.9	74.9	64.7	55.1	41.4	25.6
1957	284.0	269.0	264.0	244.0	227.0	184.0	148.0	126.0	90.4	49.2
1958	330.0	330.0	327.0	319.0	299.0	247.0	207.0	171.0	122.0	70.1
1959	51.0	49.0	48.6	47.1	43.6	39.9	33.7	29.5	24.1	17.1
1960	131.0	127.0	119.0	102.0	100.0	85.1	71.6	61.8	47.0	27.2
1961	79.0	71.0	58.7	55.2	51.1	44.3	38.6	34.7	29.6	19.6
1962	215.0	205.0	196.0	167.0	146.0	140.0	129.0	116.0	87.8	48.7
1963	92.0	89.7	86.7	84.5	79.5	66.6	59.8	52.9	41.5	25.4
1964	140.0	132.0	127.0	116.0	110.0	93.5	80.9	67.9	50.2	29.5
1965	215.0	214.0	207.0	194.0	186.0	162.0	136.0	116.0	86.5	47.6
1966	81.0	74.7	65.3	58.7	54.8	47.3	43.7	40.2	34.5	24.6
1967	133.0	110.0	102.0	93.6	91.5	84.6	75.3	65.3	47.8	28.0
1968	211.0	200.0	189.0	172.0	161.0	124.0	102.0	87.6	63.9	36.2
1969	285.0	242.0	208.0	185.0	174.0	162.0	136.0	115.0	85.4	48.5
1970	210.0	201.0	180.0	179.0	173.0	144.0	122.0	106.0	77.9	45.8
1971	126.0	124.0	123.0	118.0	105.0	91.4	77.9	71.4	58.4	35.4
1972	73.0	68.0	66.9	63.5	58.6	50.8	44.1	40.8	33.0	22.4
1973	202.0	198.0	194.0	180.0	174.0	153.0	128.0	109.0	81.0	45.5

Reference 10, Records of the USGS.

TABLE 3

MEAN MONTHLY FLOWS OF MUDDY CREEK NEAR EMERY, UTAH AT GAGE 9-3305

Water Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1911	2.0	3.1	37.7	58.3	172	131	109	64.0	19.7	13.9	3.7	2.0	
1912	3.0	5.0	9.1	52.9	138	191	109	52.8	40.5	25.5	10	5.0	
1913	7.0	8.0	16.5	52.8	169	132	80.6	51.0	27.3	13.7	9.3	8.0	
1914	9.0	9.0	14.4	41.9	271	219	72.2			13.7	9.3	8.0	
1949-50	8.2	10.4	12.7	36.4	68.4	76.5	44.2	22.8	15.1	11.3	14.0	9.9	
1950-51	9.9	9.2	11.7	33.1	90.2	108	59.6	35.9	19.4	14.4	13.8	12.0	
1951-52	9.0	5.5	11.5	85.6	306	302	115	69.3	31.8	15.7	10.8	9.9	
1952-53	14.3	13.3	14.5	14.1	43.4	106	69.3	42.6		23.0	17.2	14.6	
1953-54	9.1	9.5	9.4	22.0	53.0	40.9	28.2	16.5	15.9	14.6	10.2	9.6	
1954-55	6.0	6.3	5.9	9.6	49.5	66.0	35.7	23.2	12.9	9.6	7.8	6.9	
1955-56	8.5	8.7	11.7	18.4	71.3	78.5	44.4	22.6	14.7	10.4	9.6	9.5	
1956-57	6.7	7.5	7.7	13.0	72.6	224	137	66.7	28.9	12.5	6.7	6.1	
1957-58	14	16.1	13.5	106	267	209	75.8	44.5	28.2	26.5	11.7	15.6	
1958-59	6.7	9.2	10.7	17.4	30.5	41.9	27.5	15.3	11.7	16.5	9.6	8.0	
1959-60	5.5	5.6	12.9	30.8	80.2	85.0	47.0	19.8	17.2	9.7	6.6	6.0	
1960-61	7.7	7.5	11.2	22.4	41.9	44.0	28.0	22.7	18.1	14.5	8.5	8.4	
1961-62	7.7	8.1	8.2	79.5	132	145	90.5	54.5	24.3	10.9	12.0	9.6	
1962-63	6.1	7.5	12.4	17.1	68.7	63.5	43.3	31.2	18.3	16.5	9.9	6.5	
1963-64	7.0	7.5	7.5	16.6	69.0	95.6	59.5	42.1	17.7	12.1	9.4	8.9	
1964-65	7.0	6.0	9.2	21.7	89.1	185	125	57.2	40.2	13.7	7.6	7.0	
1965-66	10.8	11.1	18.7	34.2	53.8	39.9	30.6	28.0	12.7	9.4	5.8	7.9	
1966-67	7.1	8.0	10.1	7.8	47.7	89.2	68.4	45.8	26.9	14.9	8.1	6.7	
1967-68	18.3	10.8	9.0	6.0	6.8	7.9	13.1	78.0	155.2	71.7	42.5	23.7	
1968-69	9.0	9.4	11.4	39.7	164.9	156.6	82.0	39.3	29.3	18.2	10.8	9.0	
1969-70	7.7	8.9	10.1	19.3	127	149	84.5	57.5	28.5	30.6	14.9	8.3	
1970-71	11.0	10.7	15.0	39.4	71.5	104.0	57.2	52.4	23.5	12.7	13.3	11.8	
1971-72	9.6	9.2	14.5	22.4	46.5	54.3	30.7	28.6	13.7	15.3	13.1	10.7	
1972-73	8.2	8.0	9.5	31.8	137	161	76.4	49.1	29.9	13.7	10.4	9.3	
1973-74	9.0	9.5	12.7	27.8	146	124	54.9	39.1	24.2	18.3	12.2	10.0	
Mean Flow cfs	8.5	8.7	12.4	33.7	106.3	118.2	65.5	41.9	27.7	17.3	11.3	9.3	37.8 cfs
% Distribution	1.8	1.8	2.6	7.1	22.4	24.9	13.8	8.8	5.8	3.6	2.4	2.0	99.9%
Mean Flow Acre-Feet	523	480	762	2005	6536	7033	4027	2576	1648	1064	672	572	2990
% Distribution	1.9	1.8	2.7	7.2	23.4	25.2	14.4	9.2	5.9	3.8	2.4	2.0	99.9%

References 2, 4, 7, and 8, Records of the USGS.

and Discharges for the period of record. Based upon the historical record, it is seen that mean flows are lowest during the winter months and low flows prevail through fall and winter months. Flows increase in the spring, peak in June, and diminish by August.

It is roughly estimated that the mean annual discharge in Quitchupah Creek is about 8 cfs. The high monthly mean flow occurs in June with an estimated 25 cfs and the lows in December, January, and February at a little less than 2 cfs.

During this investigation, on July 30, 1975, the flow of Quitchupah Creek at the Mine Pump Station was measured at between 45 and 50 gpm or roughly 0.1 sec. foot. This is believed to reflect the flow from Mud Springs. Downstream 2½ miles from the pumphouse the flow was estimated to be a little over 1 cfs or about ten times greater than at the pumphouse. One mile further downstream, near the confluence of the creek in Convulsion Canyon with the North Fork of Quitchupah Creek, the North Fork was observed to flow at the rate of about 5 to 6 cfs and the combined flow to the lower reaches of the drainage was estimated at from 6 to 7 cfs.

Thus, assuming that the flow characteristics of Quitchupah Creek will be similar to those of the historic flows of the upper drainage of Muddy Creek, it is roughly estimated that the character of flow of water below the mine in Convulsion Canyon will have a peak flow of 114 cfs, a mean annual flow of 25 cfs, a highest annual mean low flow of 3 cfs, and may be expected to run dry if not fed by Mud Springs.

The expected mean distribution of the flow through the year may be expected to be similar to that of Muddy Creek as shown in Table 5. The flow

TABLE 4

MULTIPLE-DAY DURATION LOW FLOWS - MUDDY CREEK NEAR EMERY, UTAH AT GAGE 9-3305

Lowest Mean Discharge, In CFS, For the Following Number of Consecutive Days in Year Ending March 31

Year	1	3	7	14	30	60	90
1912	0.00	0.00	1.00	2.00	2.00	2.33	2.86
1913	5.00	5.00	5.00	5.00	5.00	5.97	6.62
1951	3.00	5.33	7.81	9.00	9.13	9.48	10.00
1952	6.00	6.90	7.29	7.84	8.07	8.52	8.72
1953	8.50	9.37	10.10	11.60	12.90	13.60	13.90
1954	5.00	5.83	7.53	8.68	9.00	9.14	9.30
1955	3.20	4.17	4.83	4.97	5.84	6.04	6.03
1956	3.40	3.83	4.20	4.84	7.63	8.48	8.90
1957	5.80	6.00	6.00	6.00	6.10	6.38	6.47
1958	7.90	8.60	8.97	11.30	13.00	14.50	14.50
1959	4.00	4.33	6.00	6.29	6.64	6.99	7.55
1960	3.00	3.70	4.73	5.24	5.38	5.53	5.62
1961	5.70	6.03	7.14	7.50	7.50	7.63	7.80
1962	4.00	4.63	5.50	5.90	6.09	7.40	7.53
1963	4.00	4.00	4.00	5.43	5.73	6.18	6.40
1964	2.70	3.57	5.40	6.79	7.00	7.25	7.32
1965	6.00	6.00	6.00	6.00	6.07	6.53	6.69
1966	7.00	7.00	7.37	8.82	10.30	10.60	10.80
1967	2.60	3.83	4.66	5.08	5.54	6.75	6.88
1968	4.30	4.43	4.60	4.93	5.71	6.21	6.39
1969	8.10	9.00	9.00	9.00	9.00	9.00	9.12
1970	7.00	7.00	7.00	7.00	7.33	7.95	8.30
1971	8.10	10.00	10.00	10.00	10.20	10.60	10.80
1972	8.00	8.00	8.00	8.00	8.57	9.33	9.78
1973	6.00	6.63	7.57	8.00	8.00	8.10	8.40

Reference 10, Records of the USGS.

TABLE 5

APPROXIMATE DISTRIBUTION OF MEAN MONTHLY FLOW IN QUITCHUPAH CREEK EXTRAPOLATED FROM FLOWS IN MUDDY CREEK

Month	Gage 9-3305 on Muddy Creek				Approximate Mean Monthly Flow in Quitchupah Creek					
					At Mine[1]		Above North Fork[2]		Below North Fork[3]	
	Flow Rate In CFS	Distribution As Percent	Discharge In Acre-Feet	Distribution As Percent	cfs	gpm	cfs	gpm	cfs	gpm
January	8.5	1.8	523	1.9	.010	5	.105	47	.527	237
February	8.7	1.8	480	1.9	.011	5	.107	49	.539	242
March	12.4	2.6	762	2.7	.015	7	.153	68	.769	345
April	33.7	7.1	2,005	7.2	.041	19	.415	186	2.089	938
May	106.3	22.4	6,536	23.4	.131	59	1.307	587	6.591	2,958
June	118.2	24.9	7,033	25.2	.145	65	1.454	653	7.328	3,290
July	65.5	13.8	4,027	14.4	.081	36	.806	362	4.061	1,823
August	41.9	8.8	2,576	9.2	.052	23	.515	231	2.598	1,166
September	27.7	5.8	1,648	5.9	.034	15	.341	153	1.717	771
October	17.3	3.6	1,064	3.8	.021	10	.210	96	1.073	482
November	11.3	2.4	672	2.4	.014	6	.139	62	.701	314
December	9.3	2.0	572	2.0	.011	5	.114	51	.577	259
Annual Mean	37.8		27,898		.047	21.1	.465	208.7	2.434	1,092.4

Note: Correlation of flow at gage 9-3305 with the flow at Quitchupah Creek in Convulsion Canyon at the SUFCO mine was based on flows observed on July 30, 1975. The flows in the above table are corrected from the higher flows of 1975 to the historic mean by the factor of 197.8 cfs (mean flow June 1975) ÷ 118.2 (historic mean flow for June) = 1.67 or 1.67% of normal. Correction factor is reciprocal of 1/1.67. Flow for July 30, 1975 on Muddy Creek extrapolated from mean monthly flows for July and August at 54.1 cfs.

1/ Based upon observed flow of 50 gpm in Quitchupah Creek near the mine on July 30, 1975, and corrected to normal mean flow.
Correlation factor = (gage 9-3305 flow in cfs) (50 gpm) (1/1.67) (1/448.9)/(54.1 cfs) = (gage 9-3305 flow in cfs) (1.23×10^{-3}) = flow in cfs

2/ Based upon observed flow of 500 gpm in Quitchupah Creek above the North Fork, and corrected to normal mean flow.
Correlation factor = (gage 9-3305 flow in cfs) (500 gpm) (1/1.67) (1/448.9)/(54.1 cfs) = (gage 9-3305 flow in cfs) (1.23×10^{-2}) = flow in cfs

3/ Based upon observed flow of 2,500 gpm in Quitchupah Creek below its confluence with the North Fork of Quitchupah Creek.
Correlation factor = (gage 9-3305 flow in cfs) (2500 gpm) (1/1.67) (1/448.9)/(54.1 cfs) = (gage 9-3305 flow in cfs) (6.2×10^{-2}) = flow in cfs

characteristics of Muddy Creek and the extrapolated equivalent flows in Quitchupah Creek are shown in Table 6.

WATER QUALITY

Representative samples of water from the mine and from Quitchupah Creek were collected by a technician of Dames & Moore and were analyzed by the Ford Chemical Laboratory, Inc., of Salt Lake City, Utah. Ford Chemical Laboratory, Inc., is certified by Certificate E-2 by the Bureau of Laboratories, Utah Division of Health, reissued March 15, 1975. The results of these chemical and organic analyses are compiled in Table 7. Mine water discharge samples are taken and analyzed by Coastal States in compliance with NPDES requirements. Laboratory results for samples taken in 1976 are listed in Table 8. The analytical results discussed in this section indicate that the quality of the effluent water exceeds the water quality standards set forth by the Utah State Division of Health for Class C waters. A copy of these standards is included in this report as Appendix A.

Sampling and Analyses - For this study, water samples were collected from five stations. These were:

Station	Source	Approximate Observed Flow in gpm	Location
1	West Spring ----------	20	Underground.
2	Main Sump ----------		Underground.
3	Quitchupah Creek ----------	50	Surface, from culvert near pumphouse in Convulsion Canyon near mine.
4	East Spring ----------	10	Underground.
6	Effluent into old mine workings	60	Surface at portal to old workings.

TABLE 6

SALIENT FEATURES OF FLOW FOR MUDDY CREEK ABOVE GAGE 9-3305 WITH THE ESTIMATED EQUIVALENT FLOWS FOR QUITCHUPAH CREEK OPPOSITE THE SUFCO MINE

Characteristic	Period	Historic Data on Muddy Creek		Estimated Flows in Quitchupah Creek			
		Gage 9-3305	Gage 9-3321	At Mine[1/]		At North Fork[2/]	
		cfs	cfs	cfs	gpm	cfs	gpm
Peak flow	August 6, 1973	544		0.669	300	33.728	15,140
	May 10, 1974		176				
1-day mean high flow	1952	515	-	0.633	284	31.930	14,333
1-year mean high flow	1952	81.3	-	0.100	45	5.041	2,263
Mean annual flow	63 years' data	37.07		0.047	21	2.434	1,032
	1 year's data		13.8				
Highest annual mean low flow	1958	14.4	-	0.018	8	0.893	401
Lowest flow	April 13-16, 1911	0.0	-	0.000	0	0.000	0
	Aug. 31-Sept. 2, 1973		2.2				

1/ Correlation factor is (Flow at gage 9-3305) (1.23×10^{-3}) = Flow in Quitchupah Creek at Mine. Factor derived in Footnote 1/ of Table 5.

2/ Correlation factor is (Flow at gage 9-3305)(6.2×10^{-2}) = Flow in Quitchupah Creek below North Fork.

TABLE 7

ANALYSIS OF WATERS OF QUITCHUPAH CREEK FROM SUFCO MINE TO MUDDY RIVER AT I70

Sampling Station	1	4	2	6			3	7	8	9	10	11
	Underground Flow		Main	Mine	Utah Standards For Class C Water Quality		At Quitchupah Creek		Quitchupah Creek At Browning	Muddy River At I-70 Bridge		
	West Spring	East Spring	Sump	Effluent			At Mine	At Ivie Creek	Mine			
Sample No.	75-2875							75-327		555-042	555-042	555-042
Date	7/15/75	7/31/75	7/31/75	7/31/75	Recommended	Mandatory	7/15/75	3/14/75	4/14/75	8/14/73	1/30/74	5/1/74
Turbidity (JTU)	1.20	1.70	24.0	24.0			0.95	220	441	260	160	2400
Conductivity (umhos/cm)	624.0	658.0	566.0	589.0			1018.0	1990	2330	3400	2880	1480
pH (lab)	7.70	7.20	7.70	7.70			7.69	7.10	6.80	8.0	7.20	8.2
Total Dissolved Solids	406	428.0	368.0	383	500	-	662.0	1494	1717	2740	2364	1060
Aluminum	0.05	<0.01	0.30	<0.01			0.06					
Arsenic	<0.01	<0.01	<0.01	<0.01	0.01	0.05	<0.01	0.00	0.00	0.00	0.02	0.01
Barium	0.04	<0.01	0.03	<0.01	-	1.0	0.07	0.0	0.0	0.0	3.0	0.0
Boron	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	0.0	0.13	0.075	0.10	0.2
Cadmium	0.002	<0.001	<0.001	<0.001	-	0.01	<0.001	0.004	0.008	0.000	0.000	0.007
Calcium	60.80	63.80	50.40	51.20	-	-	86.40	116	88	130.0	160	90
Chromium, Hexavalent	<0.01	<0.01	<0.01	<0.01	-	0.05	<0.01	0.000	0.003	0.002	0.003	0.003
Copper	<0.01	<0.01	<0.01	<0.01	1.0	-	<0.01	0.00	0.01	0.00	0.00	0.00
Iron-Dissolved	0.10	0.01	0.18	0.02	-	-	0.19	0.22	0.02	0.00	0.00	0.01
Total Iron	0.25	0.01	0.24	0.04	0.3	-	0.25	9.90	18.0	5.60	5.10	54.0
Lead	0.01	<0.01	<0.01	<0.01	-	0.05	0.02	0.012	0.010	0.000	0.000	0.000
Magnesium	27.36	25.92	28.80	25.44	-	-	45.60	88	90	137	125	66
Manganese	0.02	<0.01	<0.01	<0.01	0.05	-	0.03	0.00	0.02	0.00	0.01	0.00
Mercury, Susp. & Diss.	<0.001	<0.001	<0.001	<0.001	-	-	<0.01	0.0	0.0		0.00000	0.00000
Nickel	-	-	-	-	-	-	-	0.028	0.32	0.00000	0.012	0.008
Potassium	1.36	0.68	1.69	1.22	-	-	3.14	8	1.6	0.02	5	5
Selenium	<0.01	<0.01	<0.01	<0.01	-	0.01	<0.01	0.00	0.00	8	0.000	0.000
Silver	<0.001	<0.001	<0.001	<0.001	-	0.05	<0.001	0.002	0.004	0.000	0.000	0.000
Sodium	1.84	6.39	2.00	11.10	-	-	16.70	235	360	0.000	310	150
Zinc	<0.01	0.02	<0.01	<0.01	5.0	-	0.03	0.02	-	390.0	0.00	0.01
Silica	12.50	1.50	8.50	3.40	-	-	4.50	7	7	0.00	11	9
Total Alkalinity	-	-	-	-	-	-	-	-	266	13	323	252
Total Hardness	266.0	266.0	246.0	234.0	-	-	406.0	650	590	247	915	495
Bicarbonate	283.60	288.45	237.5	237.5	-	-	436.30	327	324	1014	394	304
Carbon Dioxide	-	-	-	-	-	-	-	-	82	298	39	3
Carbonate as CO_3	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	0	4.7	0	0
Chloride	8.0	6.0	10.0	8.0	250	-	18.0	-	56	1.6	110	32
Carbonate Alk'y as $CaCO_3$	234.0	138.0	196.0	196.0	-	-	360.0	268	160	66	194	151
Fluoride	0.15	0.16	0.13	0.20	1.0	2.0	0.27	0.27	0.40	148	0.45	0.31
Hydroxide	-	-	-	-	-	-	-	0	0	0.48	0	0
Nitrate as NO_3	0.11(NO_3-N)	0.05	0.13	0.14	45	-	0.13	2.15	-	0.02 as N	2.00 as N	1.25 as N
Nitrite as N	-	-	-	-	-	-	-	0.00	-	4.45 as N	0.05 as N	0.00 as N
Orthophosphorus as P	0.13(PO_4)	0.18(PO_4)	0.24(PO_4)	0.03	-	-	0.28(PO_4)	0.00	-	0.0	0.00	0.02
Sulfate as SO_4	25.0	38.0	40.50	50.0	-	-	58.50	758	940	0.10	1252	495
Surfactant MBAS	<0.01	<0.01	<0.01	<0.01	0.5	-	<0.01	0.00	0.00	1525	0.00	0.00
Ammonia N as NH_4	-	-	-	-	-	-	-	0.0	0.17 as N	0.00	0.05	0.00
Oil and Grease	*	-	*	2.5	-	-	*	-	-	-	*	*
Discharge Q (cfs)										3	4.71#	44
pH (field)										8.5	*	8.6
Temp (field) °C				12.2			16.7			27.0	0	11.5
Total Suspended Solids	1.5		75.8							570	300	8120
Biochemical Oxyden Demand	1.6	2.0	1.5	2.4		5	2.0			2.0	1.1	7.6
Dissolved Oxygen	6.50	7.15	7.80	8.2		5.5 min.	6.9			6.8	*	11.8
MPN Coliform/100 ml	<3		<3	<3		5000/100	<3			2300	230	9300
MPN Fecal Coliform/100 ml										150	93	9300
Cyanide											*	
Phenol	<0.001	<0.001	<0.001	0.001	0.001	-	<0.001					
Cyanide as CN	<0.01	<0.01	<0.01	<0.01	0.01	0.02	<0.01					
Suspended Solids	1.5		75.8	20.0			7.5					
Coliform Extract	N.A.		N.A.		0.2							

LEGEND: Less Than *Not Analyzed #Estimated Units are milligrams per liter unless otherwise specified.

SOURCE OF DATA: (a) Stations 1, 2, 3, 4, and 6. Sampled by Dames & Moore and analyzed by Ford Laboratories. Station 5 not analyzed.
(b) Station 7. Sampled by Keith Welch March 14, 19_7, and analyzed by the Utah Division of Health.
(c) Station 8. From NPDES Permit Application Browning Mine.
(d) Stations 9, 10, and 11 from Middle Colorado River Basin study.

TABLE 8

MINE WATER DISCHARGE 1976

	MARCH	MAY	JULY	AUG	SEPT.	NOV.	DEC.
Total Suspended Solids Mg./l.	20	28	17	23.1	12.3	5.2	9.5
Total Dissolved Solids Mg./l.	282	382	311	267	291	278	295
Oil and Grease Mg./l.	1.0	0.7	0.5	0.7	0.1	nil	0.3
pH Units	8.1	8.3	8.2	7.9	-	7.2	7.0

Samples were collected in clean plastic bottles. Separate samples were collected for general analyses, cyanide and phenol and were fixed appropriately. Samples for BOD were placed on ice and transported immediately to Salt Lake City for analysis. Results of the analyses are shown in Table 7, and in Appendix A. Flows were estimated. Station 5 was planned but was not sampled.

Comparison Samples and Analyses - Previous sampling of the waters of Quitchupah Creek and the Muddy River are available from the Utah State Division of Health and from the NPDES application for permit submitted to the EPA by the Consolidation Coal Company at its Browning Mine on Christianson Wash which also empties into the lower reach of Quitchupah Creek about ten miles downstream from the SUFCo Mine. The results of these previous analyses, together with a tabulation of applicable State of Utah Water Standards are also shown on Table 7 (Ref. 9) and in Appendix A. Mine discharge from 1976 is shown in Table 8.

Inspection of the results of the water analyses of the waters from the West and East Springs, the main sump, and the effluent into the old mine workings, and comparison with the standards as shown on Table 7 and Table 8, reveals that they meet or exceed the applicable state standards. Also, by comparison with the results of present and previous analyses of the waters of Quitchupah Creek, it is evident that the effluent is of superior quality to the natural surface waters downstream from the mine. The Utah Division of Health Standards are shown in Appendix B.

The effluent waters contain no visible objectionable deposits, floating debris, oil, scum, or other matter and have no objectionable odor or taste. The seepages from both the West and East Springs have negligible turbidity

and suspended solids and are used directly for culinary water; however, the effluent from the main sump does have visible turbidity and color from the fine suspended solids acquired during its flow across the floor of the mine workings. Nevertheless, the turbidity and suspended solids are considerabley less than those of the natural surface flow of Quitchupah Creek near Christianson Wash ten miles downstream near its confluence with Ivie Creek about 14 miles downstream, and the flow of Muddy River where it crosses I-70 17 miles downstream from the mine. The station of Muddy River is a sampling point for the Middle Colorado River Basin for which three rounds of analyses are available on the dates of August 14, 1973, January 30, 1974, and May 1, 1974. The summer discharge temperature of the mine effluent is about 52°F (12.2° C) and may be expected to be about the same year long. A measured summer temperature of Quitchupah Creek is 62° F (16.7° C).

General Character of Surface Waters Near the Mine - The general character of the quality of the surface waters near the mine is determined by the nature of the sedimentary formations and derivative soils over and through which the water flows as it descends into the water basins, and by the distance from its source in the upper watersheds of the high plateau areas.

This has been discussed in a general manner by Doelling et al (Ref. 3):

> "The water for all creeks in the area of the Wasatch Plateau proper has a low dissolved solids content (Fig. 21); it ranges between 100 and 300 ppm except in the south area where the range is between 10 and 100. The streams flowing across the Mancos Shale pick up chemical matter from irrigation return water and part from the chemical nature of the Mancos. The increase is gradual from 300 ppm to over 1,200 ppm in a west to east direction."

As may be noted from a plate given in Doelling's report and reproduced herein as Plate 4, the indicated quality of the surface water near the mine is very high (10-100 ppm of dissolved solids). Downstream toward the east, the dissolved solids increase and the quality of the surface water is degraded.

Water Balance - Currently, water is being pumped from the active workings at the rate that the water is seeping from the active workings. This rate is an average of about 144,000 gallons per day.

Of this flow, about 4,000 gallons per day are used for sanitary purposes at the surface installation at the portal.

During the summer months, about 94,000 gallons of this water is used to sprinkle the haulage road to Interstate 70 to eliminate fugitive dust.

During six to nine dry and frost-free months, the effluent flow which is discharged into East Spring Canyon is about 47,000 gallons per day.

Mine seepage ----------	144,000	gallons	per	day
Sanitary water use ----------	4,000	"	"	"
Sprinkling ----------	94,000	"	"	"
Balance as effluent ----------	46,000	"	"	"

During the winter and freezing months when no sprinkling is utilized, the effluent is an average of about 140,000 gallons per day.

It is anticipated that new faults and seepage flows will be encountered as new workings are advanced. Although the flow from earlier seeps may be expected to diminish, new seeps will be encountered as the workings are advanced. Thus, it is not possible to project future flows and they may be expected to be variable.

Water Users - Only two users of water from Quitchupah Creek have been noted in the immediate vicinity of the mine.

The first is a water right held by SUFCo for use in the mine. (Ref. 10). Application A40776 has been filed and granted by the Utah Division of Water Rights to SUFCo for 0.50 cfs from a spring located near the juncture of Quitchupah and East Spring Creeks and the point of withdrawal is at a pumphouse located in the SW¼ of the SE¼ of Section 12, T. 22 S., R. 4 E., as shown on Plate 2.

The second water right accrued to a 1000.40 acre parcel of land by grant of the State of Utah in 1921. The acreage is located adjacent to Quitchupah Creek from about two to seven miles downstream from the mine and the owner of record is the Kemmerer Coal Company (Ref. 11). Water was observed to be diverted from Quitchupah Creek during this investigation on July 8, 1975, at a point located in the S½ of the SE¼ of Section 15, T. 22 S., R. 5 E., and the cultivated lands are shown on Plate 4. The water was diverted by a ditch leading to irrigated fields of alfalfa. The amount of the water right is not known; however, the flow in Quitchupah Creek above the ditch was observed to be about 10 cfs.

Water users further downstream were not investigated; however, it is noted that the Browning Coal Mine lies in the NW¼ of Section 33, T. 22 S., R. 6 E., about eight miles downstream from the SUFCo Mine, and that Consolidation Coal Company, the owner of the property, has made application for an NPDES permit.

IMPACT OF THE MINING OPERATION ON HYDROLOGY OF AREA

As the quality of the effluent water meets or exceeds existing standards of the State of Utah for the Class C water of Quitchupah Creek, and as the

sampling and analyses of this and previous investigations indicates that the receiving waters are of generally lower quality than the effluent, it is believed that the impact of the mining operation is not deleterious to existing water quality. As the temperature of the effluent remains about the same year long, it tends to moderate the ambient changes in temperature in Quitchupah Creek.

In terms of flow rate and discharge volume, a projected maximum release of 300,000 gpd as equivalent to 208.3 gpm or roughly 0.7 cfs is not expected to adversely or significantly affect natural surface water conditions or downstream users.

Three conditions of flow are analyzed to determine the impact of the projected effluent upon Quitchupah Creek and the surrounding environment:

1. Peak flow
2. Mean annual flow
3. Lowest flow

PEAK FLOW

From Table 6, the historical peak flow in Quitchupah Creek occurred on or about August 6, 1973, and is roughly estimated to have been approximately 0.7 cubic feet per second or 300 gallons per minute. Downstream at the juncture of the main branch with the North Fork, the flow could have been considerably higher and is estimated to have been as high as 34 cubic feet per second or about 15,000 gallons per minute.

Assuming that this flow could represent a sustained flood flow, the rate of projected maximum release of 300,000 gallons per day in accordance with this application would amount to about 60 percent of the flow in Quitchupah Creek near the mine and about 1 percent of the flow further downstream below the North

Fork. Under such conditions, any release from the mine on a sustained basis would be diluted downstream by natural surface flow by a factor of roughly 10^2. Under this dilution flow, the quality of the effluent could be 100 times worse and still be dispersed to acceptable standards to downstream users. Consequently, no significant adverse impact is foreseen under conditions of sustained flood or peak flows.

MEAN ANNUAL FLOW

From Table 6, 63 years of data indicate that the mean annual flow of Quitchupah Creek is roughly on the order of .05 cubic feet per second or a little over 20 gallons per minute near the mine and over 3 cubic feet per second or a little over 1,000 gallons per minute downstream.

Under these conditions, which are considered to be normal or average, the maximum release of 300,000 gallons per day would represent about a ten-fold increase of the surface flow at the mine. Downstream below the confluence with the North Fork, the projected would be about 21 percent of the surface flow.

Under these conditions, the projected effluent would be diluted downstream by a factor of 5, or the parameters of quality could be five times as high as they are and still allow the water of Quitchupah Creek to flow downstream to users within the required standards for Class C waters.

LOWEST FLOW

From Table 6, it can be seen that the bed of Quitchupah Creek may be expected to be dry from time to time. Mud Spring provides a minimal flow in

Quitchupah Creek of about 50 gallons per minute or about 0.1 cfs, or less, during periods of drought. If the period of drought were prolonged and severe, it may be expected that the effluent would be absorbed in the bed of the stream and would return to the ground water regime. As this effluent is originally derived from the same ground water regime, return of this flow cannot be considered as a significant impact, particularly since the water quality is essentially unchanged.

If a low flow from Mud Spring were to keep the bed saturated, the addition of 300,000 gpm or about 0.46 cfs would flow downstream at a rate comparable to, or less than, the highest annual mean low flow as estimated in Table 6 at the confluence with the North Fork of Quitchupah Creek which is projected at 0.893 cfs or about 401 gpm. Duplication of such natural flow conditions is not judged to be of significant or deleterious impact, particularly since the quality of the effluent is comparable to or better than the natural flow.

IMPLICATION OF DISSOLVED SOLIDS TO THE SALT PROBLEM OF THE COLORADO RIVER SYSTEM

It might be argued that even though the effluent meets the standards for Class C waters, it still adds undesirable salts to the Colorado River system, and thus is contrary to the intent of the Colorado River Compact. Such an argument would be fallacious, in that since the effluent contains less total dissolved solids than the surface water flow, the effluent constitutes dilution water and thus is a beneficial addition to the Colorado River flow. In fact, if the concept of "zero discharge" were applied to this case, the loss of the mine effluent would be a loss to man and his environment. As analyzed, low conditions do not constitute a significant degradation of the environment.

HYPOTHETICAL WORST CASE

From this analysis, it is projected that the worst hypothetical situation would be under conditions of sustained low flow where the soils and ground water regime of the bed of Quitchupah Creek would be saturated, while containing little or no surface flow to provide dilution. Under such conditions, the effluent flow would be carried downstream exactly in the condition and quality as it would be discharged from the mine. However, even under these conditions, present sampling of the effluent indicates that it is of high quality so as to be useful for most purposes. Even though the effluent may be slightly turbid and contain some suspended solids, the content of suspended solids is lower than the natural waters of Quitchupah Creek and this is considered to be neither adverse no significant.

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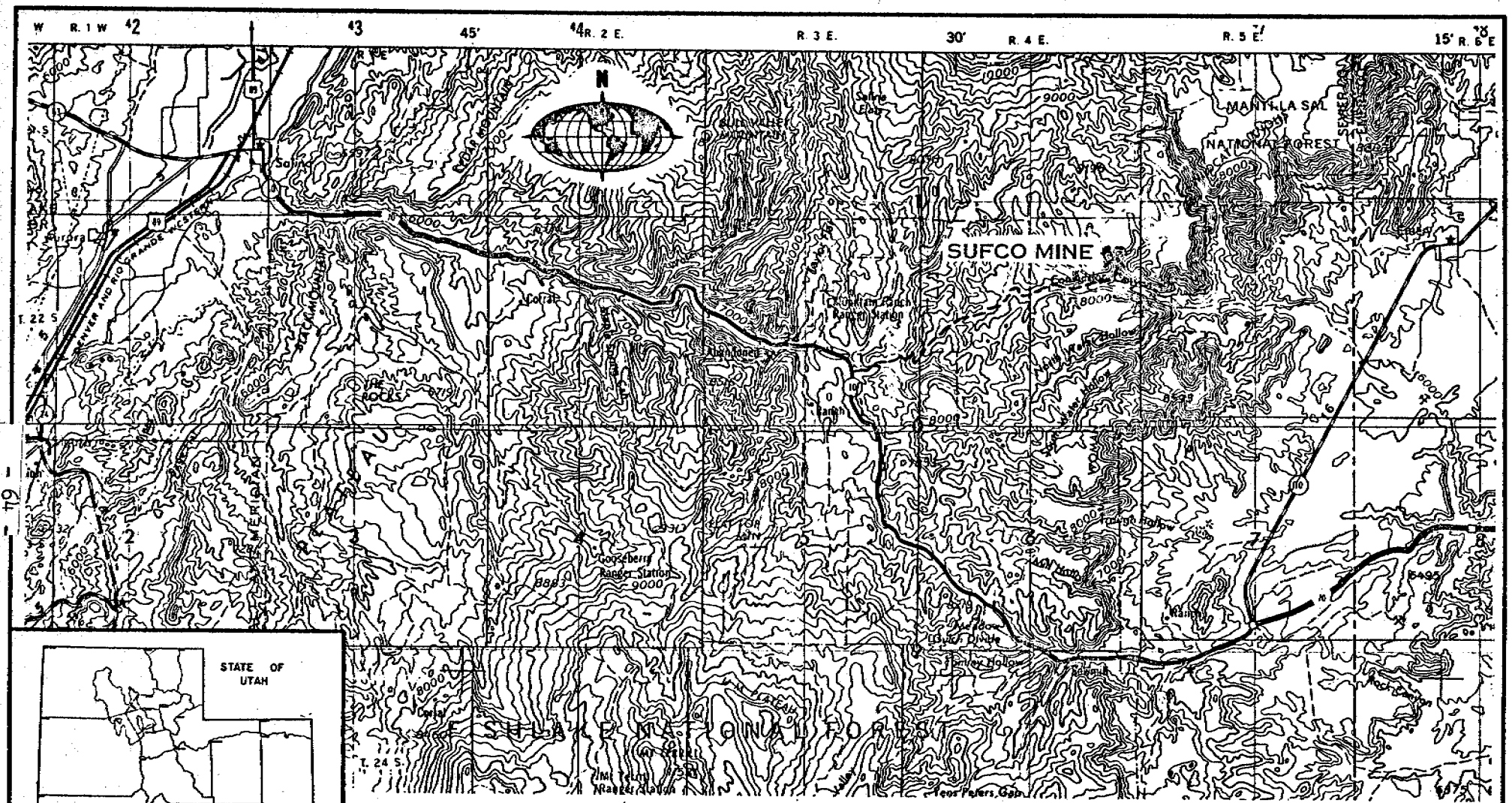
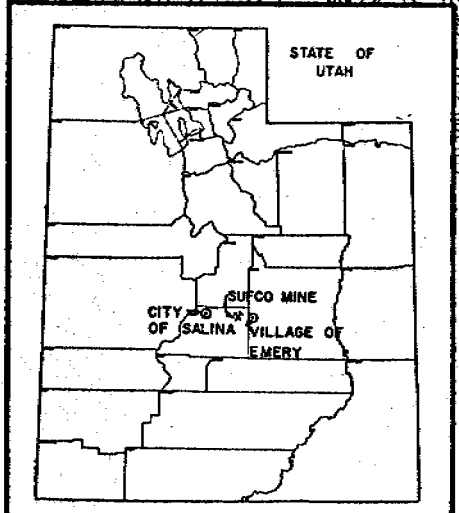
10. Leon Jensen, Water Resources Division, U.S. Geological Survey, Personal communication, July 16, 1975.

11. Utah State Engineer, Division of Water Rights, Department of Natural Resources, from Public Records, July, 1975.

12. Records of Sevier County, Deed Bood 42, Page 361 and Deed Book 62, Pages 225 to 227. Office of the Sevier County Recorder, Richfield, Utah. Personal communication from R.L. Olcott, County Recorder, July 18, 1975.

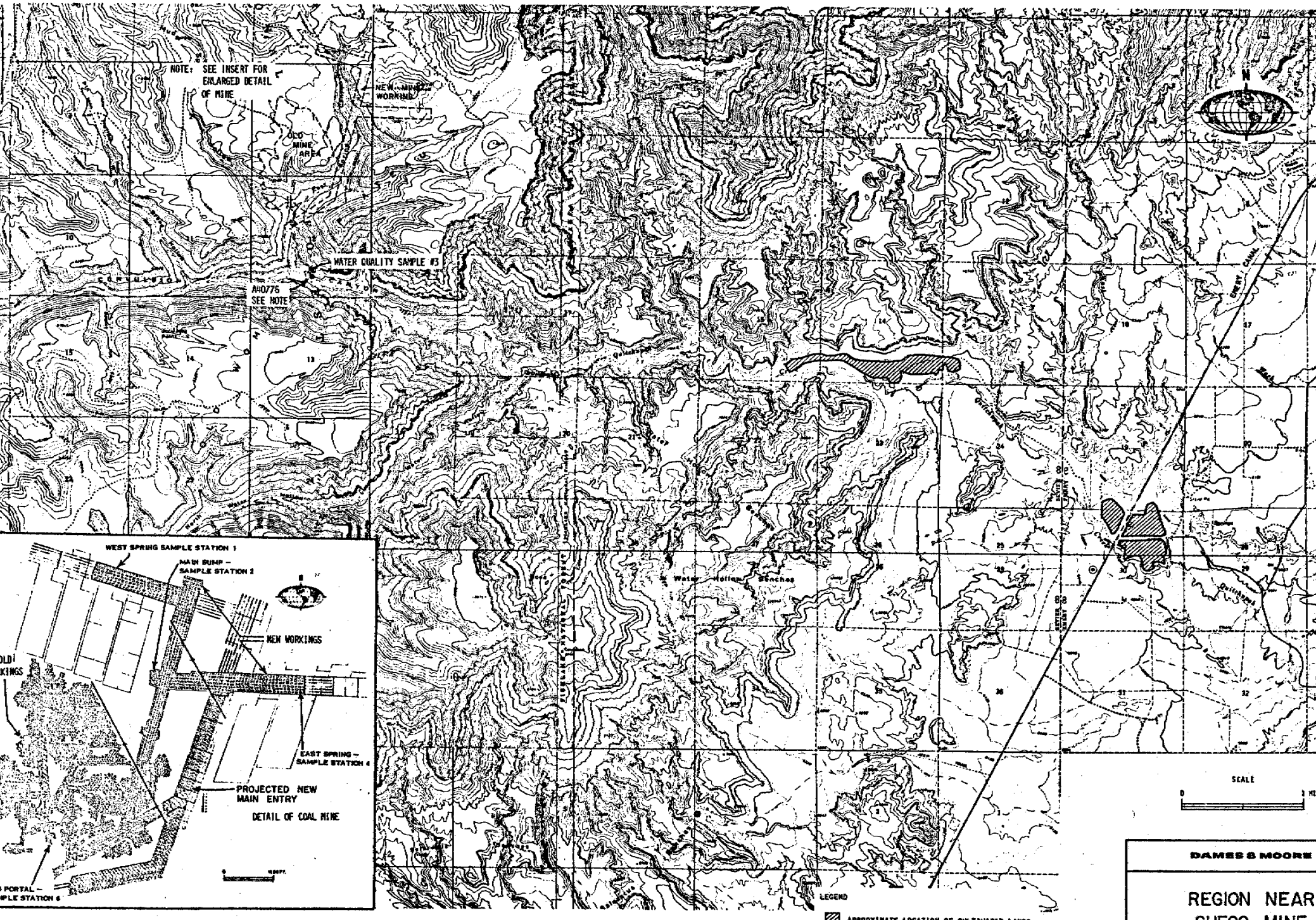




SALINA-EMERY AREA
SHOWING LOCATION OF SUFCO MINE

DAMES & MOORE

PLATE 1



NOTE: COASTAL STATES ENERGY CORPORATION WATER RIGHT APPLICATION AND AREA LOCATION.

DAMES & MOORE

REGION NEAR
SUFCO MINE

PLATE

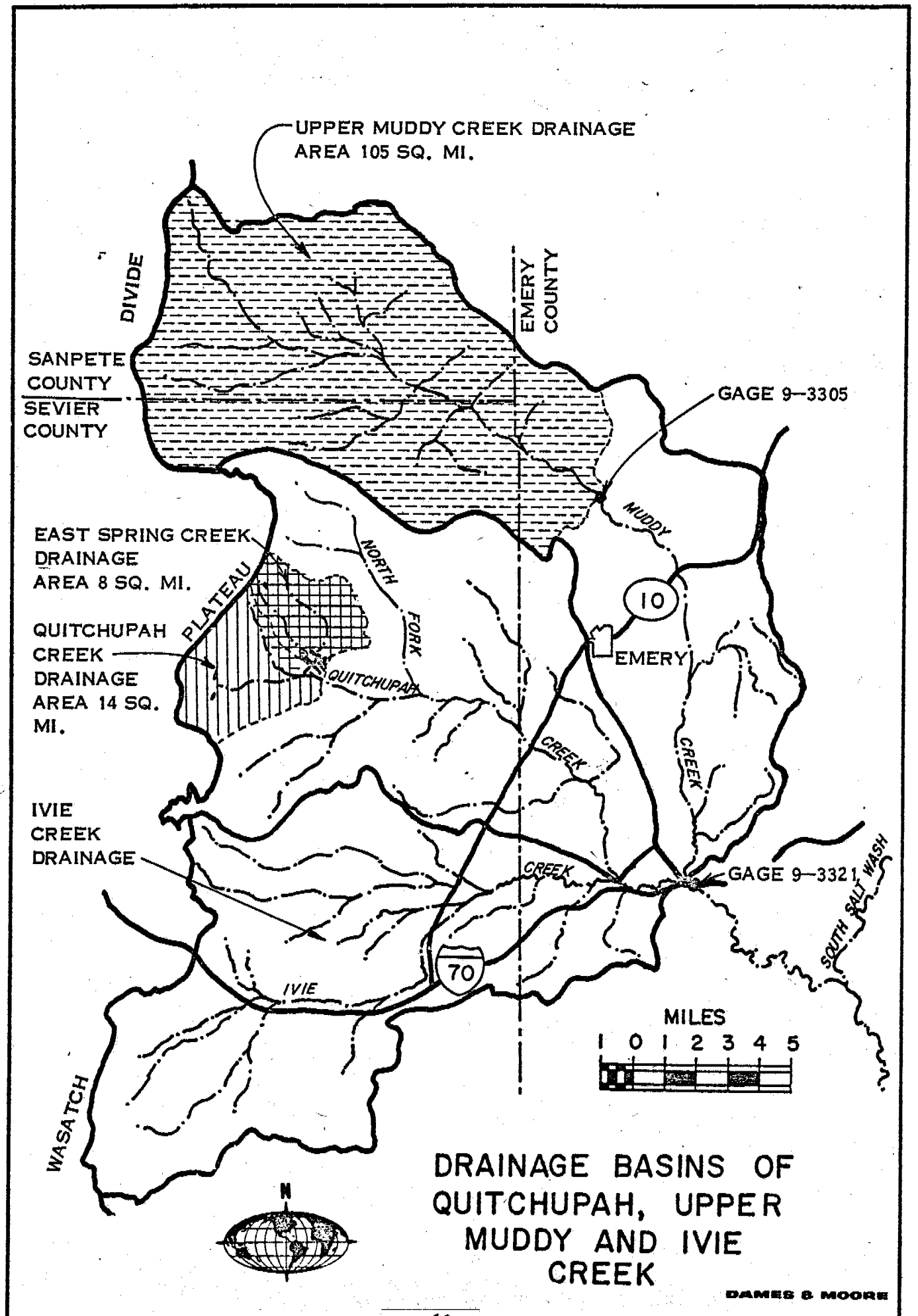
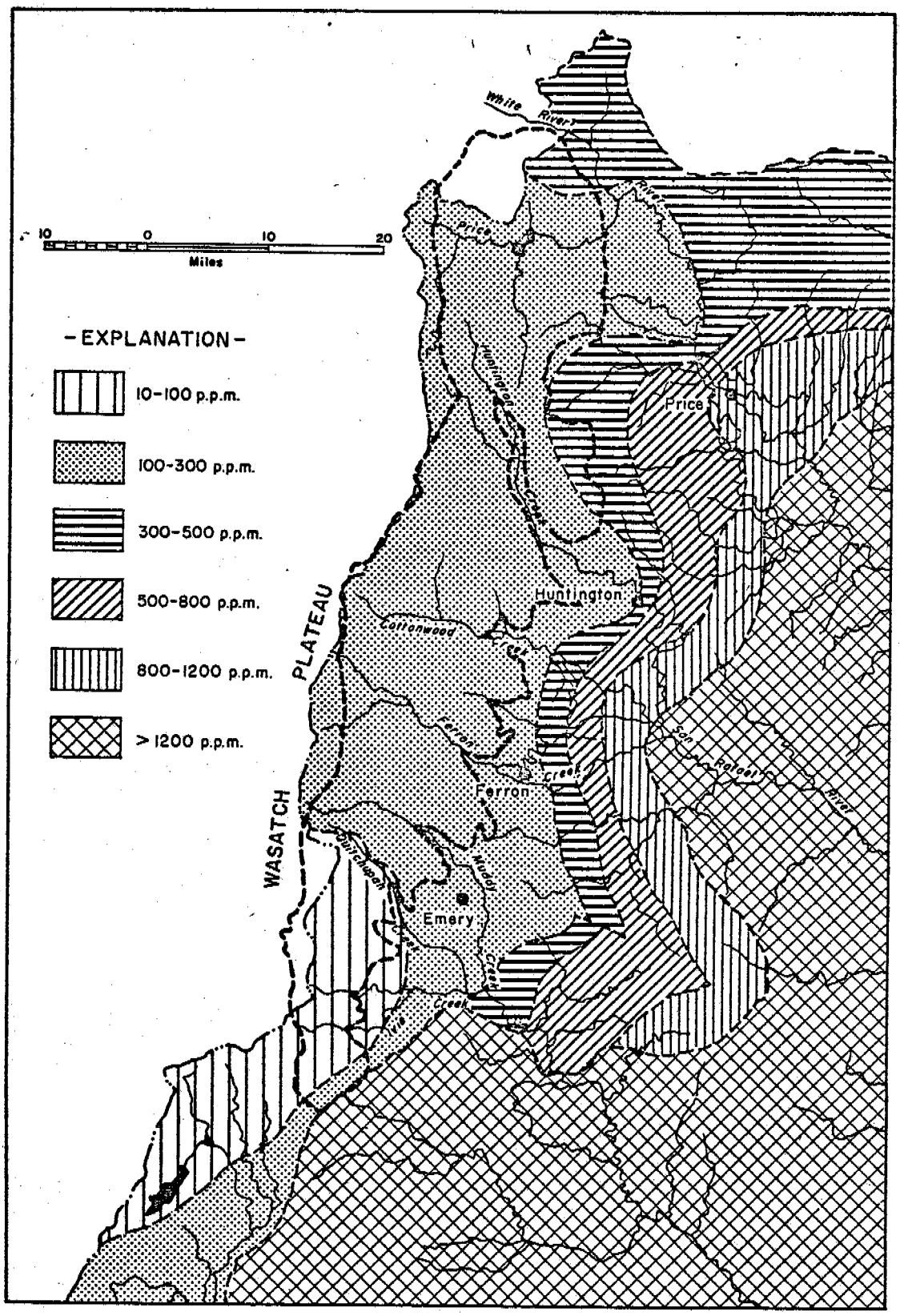

UPPER MUDDY CREEK DRAINAGE
AREA 105 SQ. MI.
DIVIDE
EMERY COUNTY
SANPETE COUNTY
SEVIER COUNTY
GAGE 9-3305
MUDDY
EAST SPRING CREEK DRAINAGE AREA 8 SQ. MI.
PLATEAU
NORTH FORK
QUITCHUPAH CREEK DRAINAGE AREA 14 SQ. MI.
QUITCHUPAH
10
EMERY
CREEK
CREEK
IVIE CREEK DRAINAGE
CREEK
GAGE 9-3321
SOUTH SALT WASH
70
IVIE
MILES
1 0 1 2 3 4 5
WASATCH
N
DRAINAGE BASINS OF QUITCHUPAH, UPPER MUDDY AND IVIE CREEK
DAMES & MOORE

PLATE 3



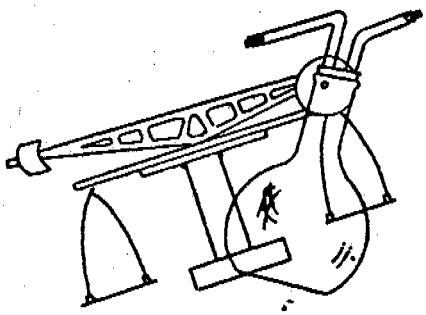
DISSOLVED SOLIDS OF SURFACE WATERS IN WASATCH PLATEAU

REFERENCE H.H. DOELLING - CENTRAL UTAH COAL FIELDS, WASATCH PLATEAU

DAMES & MOORE

PLATE 4

APPENDIX A



Ford Chemical LABORATORY, INC.

Bacteriological and Chemical Analysis

40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

Date: July 21, 1975

Name Dames & Moore, Eng.

Address 250 East Broadway

Salt Lake City, Utah

CERTIFICATE OF ANALYSIS

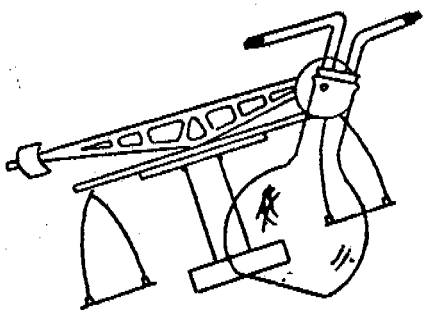
75-2875

W. Spring

Sample Water received on July 15, 1975 under Job No. 6701-002-06 labeled #1 Main Seepage Area from 4-inch discharge pipe.

Turbidity	1.20 JTU	Fluoride as F	0.15 mg/l
Conductivity	624.0 umhos/cm	Total Hardness as $CaCO_3$	266.0 mg/l
pH	7.70	Iron (Total) as Fe	0.25 mg/l
Total Dissolved Solids at 180° C.	406.0 mg/l	Iron (Filtered) as Fe	0.10 mg/l
Alkalinity as $CaCO_3$	234.0 mg/l	Lead as Pb	<0.01 mg/l
Aluminum as Al	0.05 mg/l	Magnesium as Mg	27.36 mg/l
Arsenic as As	<0.01 mg/l	Manganese as Mn	0.02 mg/l
Bicarbonate as HCO_3	283.60 mg/l	Mercury as Hg	<0.001 mg/l
Barium as Ba	0.04 mg/l	Nitrate as NO_3—N	0.11 mg/l
Boron as B	<0.01 mg/l	Phosphate as PO_4	0.13 mg/l
Cadmium as Cd	0.002 mg/l	Potassium as K	1.36 mg/l
Calcium as Ca	60.80 mg/l	Selenium as Se	<0.01 mg/l
Carbonate as CO_3	<0.01 mg/l	Silica as SiO_2	12.50 mg/l
Chloride as Cl	8.0 mg/l	Silver as Ag	<0.001 mg/l
Chromium as Cr (Hex)	<0.01 mg/l	Sulfate as SO_4	25.0 mg/l
Cyanide as Cn	<0.01 mg/l	Sodium as Na	1.84 mg/l
Copper as Cu	<0.01 mg/l	Zinc as Zn	<0.01 mg/l
Phenol	<0.001 mg/l	Total Coliform	<3 MPN/100 ml
Bio-Chemical Oxygen Demand	1.6 mg/l	Suspended Solids	1.5 mg/l
Dissolved Oxygen	6.50 mg/l		
Surfactants	<0.01 mg/l		

Ford Chemical Laboratory, Inc.



Ford Chemical LABORATORY, INC.

Bacteriological and Chemical Analysis

40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

Date: July 21, 1975

Name Dames & Moore, Eng.

Address 250 East Broadway

Salt Lake City, Utah

CERTIFICATE OF ANALYSIS

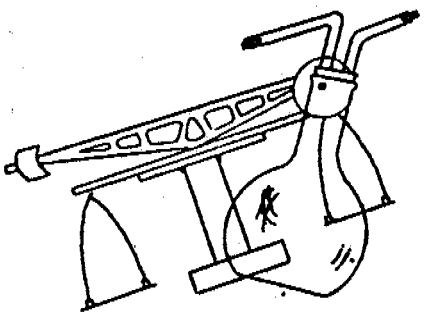
75-2876

Main Sump

Sample Water received on July15, 1975 under Job no. 6701-002-06 labeled #2 at Main Water Dam.

Turbidity	24.0	JTU	Fluoride as F	0.13	mg/l
Conductivity	566.0	umhos/cm	Total Hardness as $CaCO_3$	246.0	mg/l
pH	7.70		Iron (Total) as Fe	0.24	mg/l
Total Dissolved Solids at 180° C.	368.0	mg/l	Iron (Filtered) as Fe	0.18	mg/l
Alkalinity as $CaCO_3$	196.0	mg/l	Lead as Pb	<0.01	mg/l
Aluminum as Al	0.30	mg/l	Magnesium as Mg	28.80	mg/l
Arsenic as As	<0.01	mg/l	Manganese as Mn	<0.01	mg/l
Bicarbonate as HCO_3	237.5	mg/l	Mercury as Hg	<0.001	mg/l
Barium as Ba	0.03	mg/l	Nitrate as NO_3—N	0.13	mg/l
Boron as B	<0.01	mg/l	Phosphate as PO_4	0.25	mg/l
Cadmium as Cd	<0.001	mg/l	Potassium as K	1.69	mg/l
Calcium as Ca	50.40	mg/l	Selenium as Se	<0.01	mg/l
Carbonate as CO_3	<0.01	mg/l	Silica as SiO_2	8.50	mg/l
Chloride as Cl	10.0	mg/l	Silver as Ag	<0.001	mg/l
Chromium as Cr (Hex)	<0.01	mg/l	Sulfate as SO_4	40.50	mg/l
Cyanide as Cn	<0.01	mg/l	Sodium as Na	2.00	mg/l
Copper as Cu	<0.01	mg/l	Zinc as Zn	<0.01	mg/l
Phenol	<0.001	mg/l	Total Coliform	<3	MPN/100 ml
Bio-Chemical Oxygen Demand	1.5	mg/l	Suspended Solids	75.8	mg/l
Dissolved Oxygen	7.80	mg/l			
Surfactants	<0.01	mg/l			

Ford Chemical Laboratory, Inc.



Ford Chemical LABORATORY, INC.

Bacteriological and Chemical Analysis

40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

Date: July 21, 1975

Name Dames & Moore, Eng.

Address 250 Broadway

Salt Lake City, Utah

CERTIFICATE OF ANALYSIS

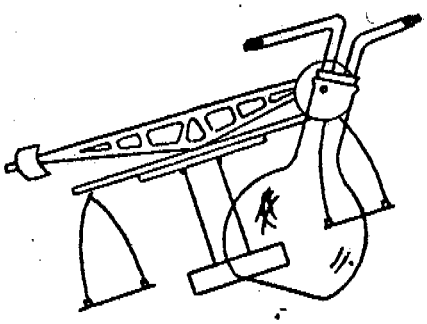
75-2877

Quitch. crk.

Sample Water received on July 15, 1975 under Job No. 6701-002-06 labeled #3 upstream of pumphouse and culvert.

Turbidity	0.95 JTU	Fluoride as F	0.27 mg/l
Conductivity	1,018.0 umhos/cm	Total Hardness as $CaCO_3$	406.0 mg/l
pH	7.69	Iron (Total) as Fe	0.25 mg/l
Total Dissolved Solids at 180° C.	662.0 mg/l	Iron (Filtered) as Fe	0.19 mg/l
Alkalinity as $CaCO_3$	360.0 mg/l	Lead as Pb	0.02 mg/l
Aluminum as Al	0.06 mg/l	Magnesium as Mg	45.60 mg/l
Arsenic as As	< 0.01 mg/l	Manganese as Mn	0.03 mg/l
Bicarbonate as HCO_3	436.30 mg/l	Mercury as Hg	< 0.01 mg/l
Barium as Ba	0.07 mg/l	Nitrate as NO_3—N	0.13 mg/l
Boron as B	< 0.01 mg/l	Phosphate as PO_4	0.28 mg/l
Cadmium as Cd	< 0.001 mg/l	Potassium as K	3.14 mg/l
Calcium as Ca	86.40 mg/l	Selenium as Se	< 0.01 mg/l
Carbonate as CO_3	< 0.01 mg/l	Silica as SiO_2	4.50 mg/l
Chloride as Cl	18.0 mg/l	Silver as Ag	< 0.001 mg/l
Chromium as Cr (Hex)	< 0.01 mg/l	Sulfate as SO_4	58.50 mg/l
Cyanide as Cn	< 0.01 mg/l	Sodium as Na	16.70 mg/l
Copper as Cu	< 0.01 mg/l	Zinc as Zn	0.03 mg/l
		Total Coliform	< 3 MPN/100 ml
		Suspended Solids	7.6 mg/l
Phenol	< 0.001 mg/l		
Bio-Chemical Oxygen Demand	2.0 mg/l		
Dissolved Oxygen	6.90 mg/l		
Surfactants	< 0.01 mg/l		

Ford Chemical Laboratory, Inc.



Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

Date: August 6, 1975

Name Dames & Moore, Eng.

Address 250 East Broadway
Salt Lake City, Utah

CERTIFICATE OF ANALYSIS

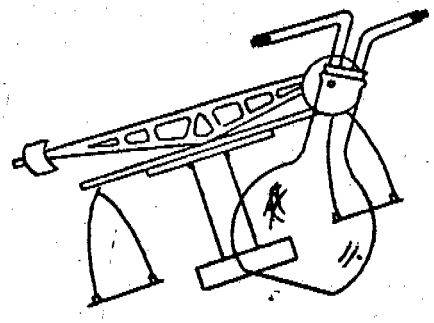
75-3129

Sample Coastal States Energy Station #4 received on E. Spg.
July 31, 1975, Job #002:

Turbidity	1.70 JTU	Fluoride as F	0.16 mg/l
Conductivity	658.0 umhos/cm	Total Hardness as $CaCO_3$	266.0 mg/l
pH	7.20	Iron (Total) as Fe	0.01 mg/l
Total Dissolved Solids at 180° C.	428.0 mg/l	Iron (Filtered) as Fe	0.01 mg/l
Alkalinity as $CaCO_3$	238.0 mg/l	Lead as Pb	<0.01 mg/l
Aluminum as Al	<0.01 mg/l	Magnesium as Mg	25.92 mg/l
Arsenic as As	<0.01 mg/l	Manganese as Mn	<0.01 mg/l
Bicarbonate as HCO_3	288.45 mg/l	Mercury as Hg	<0.001 mg/l
Barium as Ba	<0.01 mg/l	Nitrate as NO_3—N	0.05 mg/l
Boron as B	<0.01 mg/l	Phosphate as PO_4	0.18 mg/l
Cadmium as Cd	<0.001 mg/l	Potassium as K	0.68 mg/l
Calcium as Ca	63.80 mg/l	Selenium as Se	<0.01 mg/l
Carbonate as CO_3	<0.01 mg/l	Silica as SiO_2	1.50 mg/l
Chloride as Cl	6.0 mg/l	Silver as Ag	<0.001 mg/l
Chromium as Cr (Hex)	<0.01 mg/l	Sulfate as SO_4	38.0 mg/l
Cyanide as Cn	<0.01 mg/l	Sodium as Na	6.39 mg/l
Copper as Cu	<0.01 mg/l	Zinc as Zn	0.02 mg/l
		Phenol	<0.001 mg/l

Bio-Chemical Oxygen Demand 2.0 mg/l
Dissolved Oxygen 7.15 mg/l
Surfactants <0.01 mg/l

Lyle S. Ford (CB)
Ford Chemical Laboratory, Inc.



Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

Date: August 6, 1975

Name Dames & Moore, Eng.

Address 250 East Broadway

Salt Lake City, Utah

CERTIFICATE OF ANALYSIS

75-3130

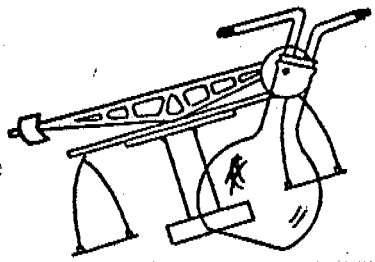
Sample Coastal States Energy, Station #6 received on Mine Eff.

July 31, 1975, Job #002:

Turbidity	24.0 JTU	Fluoride as F	0.20 mg/l
Conductivity	589.0 umhos/cm	Total Hardness as $CaCO_3$	234.0 mg/l
pH	7.70	Iron (Total) as Fe	0.04 mg/l
Total Dissolved Solids at 180° C.	383.0 mg/l	Iron (Filtered) as Fe	0.02 mg/l
Alkalinity as $CaCO_3$	196.0 mg/l	Lead as Pb	<0.01 mg/l
Aluminum as Al	<0.01 mg/l	Magnesium as Mg	25.44 mg/l
Arsenic as As	<0.01 mg/l	Manganese as Mn	<0.01 mg/l
Bicarbonate as HCO_3	237.50 mg/l	Mercury as Hg	<0.001 mg/l
Barium as Ba	<0.01 mg/l	Nitrate as NO_3-N	0.14 mg/l
Boron as B	<0.01 mg/l	Phosphate as PO_4	0.03 mg/l
Cadmium as Cd	<0.001 mg/l	Potassium as K	1.22 mg/l
Calcium as Ca	51.20 mg/l	Selenium as Se	<0.01 mg/l
Carbonate as CO_3	<0.01 mg/l	Silica as SiO_2	3.40 mg/l
Chloride as Cl	8.0 mg/l	Silver as Ag	<0.001 mg/l
Chromium as Cr (Hex)	<0.01 mg/l	Sulfate as SO_4	50.0 mg/l
Cyanide as Cn	<0.01 mg/l	Sodium as Na	11.10 mg/l
Copper as Cu	<0.01 mg/l	Zinc as Zn	<0.01 mg/l
		Phenol	<0.001 mg/l

Bio-Chemical Oxygen Demand 2.4 mg/l
Dissolved Oxygen 8.20 mg/l
Surfactant <0.01 mg/l

Lyle A. Ford C.W.
Ford Chemical Laboratory, Inc.



A-6

Ford Chemical LABORATORY

Bacteriological and Chemical Analysis

40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115

WATER SAMPLE FOR BACTERIOLOGIC EXAMINATION

Water Sample No. 4493
Name Dames & Moore
Address
Date of Collection 10-6-75 Time

Chlorinated ☐ Unchlorinated ☐

Residual _____ ppm.

Source Coastal States Energy
Sampling Point
Sample Collected By
Submitted By

Volume ml.	Presumptive		Confirmed (BGL BB)					Fecal at 44.5° C.				
	24	48	24	48	24	48	T	24	48	24	48	T
10.0	/3	/3	/	/	/	/	/3	/	/	/	/	/3
1.0	0/3	1/3	/	/	0	1	0/3	/	/	/	/	/3
10-1	0/3	1/3	/	/	1	/	0/3	/	/	/	/	/3
10-2	0/3	0/3	/	/	/	/	0/3	/	/	/	/	/3
10-3	0/3	0/3	/	/	/	/	0/3	/	/	/	/	/3
10-4	0/3	0/3	/	/	/	/	0/3	/	/	/	/	/3
10-5	/3	/3	/	/	/	/	/3	/	/	/	/	/3
10-6	/3	/3	/	/	/	/	/3	/	/	/	/	/3

MPN Coliform Results 23 /100 ml.

MPN Fecal Results /100 ml.

Volume ml.		10	10	10	10	10
Presumptive	24 hr.					
	48 hr.					
Confirmed	24 hr.					
	48 hr.					

EXAMINE FOR:
- Coliform in 10 ml. volume ☐
- M.P.N. Coliforms ☒
- Fecal Coliform ☐
- Standard plate count ☐ /ml.

Date Received Ocotber 6, 1975

Date Reported October 9,1975

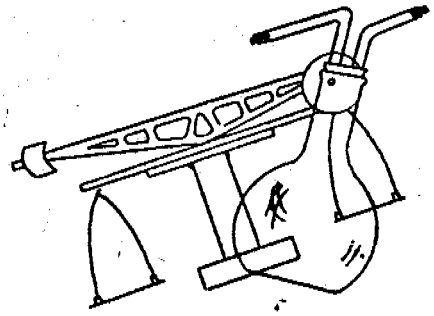
Lyle Ford

Ford Chemical La

Form 7A

SATISFACTORY ☐
UNSATISFACTORY ☐

Coliform 10 ml. Volume



Ford Chemical
LABORATORY, INC.
Bacteriological and Chemical Analysis
40 WEST LOUISE AVENUE
SALT LAKE CITY, UTAH 84115
PHONE 485-5761

November 14, 1975

CERTIFICATE OF ANALYSIS
75-5137

Dames & Moore, Eng.
250 East Broadway
Salt Lake City, Utah

Gentlemen:

The following analysis is on sample of water received on October 6, 1975:

Sample: Water from Coastal States Energy

	Results
Total Suspended Solids	20.0 mg/l
Oil and Grease	2.5 mg/l

Sincerely,

FORD CHEMICAL LABORATORY, INC.

Lyle S. Ford

LSF:lh

APPENDIX B

UTAH STATE DIVISION OF HEALTH
SUMMARY OF CLASS "C" WATER QUALITY REQUIREMENTS
August 2, 1971

It shall be unlawful to discharge wastes resulting in:

- Objectionable deposits
- Floating debris, oil, scum and other matters
- Objectionable color, odor, taste, turbidity
- Interference with Class "C" water uses

The following standards shall not be violated:

	Limits			Limits			Limits	
	Recommended	Mandatory		Recommended	Mandatory		Recommended	Mandatory
Item	Mg/l	Mg/l	Item	Mg/l	Mg/l	Item	Mg/l	Mg/l
TDS	500	-	Cu	1.0	-	NO_3	45	-
As	0.01	0.05	CN	0.01	0.02	Phenol	0.001	-
Ba	-	1.0	F	1.0	2.0*	Se	-	0.01
CCE	0.2	-	Fe	0.3	-	Ag	-	0.05
Cd	-	0.01	Pb	-	0.05	SO_4	250	-
Cl	250	-	Mn	0.05	-	MBAS	0.5	-
Cr	-	0.05				Zn	5.0	-

MPN Coliforms 5000/100 upper limit (average)
BOD 5 mg/l upper limit
DO 5.5 mg/l lower limit
Radionuclides not to exceed 1/30 of the MPC_w** values as defined in National Bureau of Standards Handbook 69

CLASS "CC"
2^{o} F. incremental increase and not above 68^{o} F.; DO 6 mg/l minimum

CLASS "CW"
4^{o} F. incremental increase and not above 80^{o} F.; DO 6 mg/l minimum

CLASS "CR"
MPN Coliforms 1000/100 ml. upper limit (average)

CLASS "CCR"
Same as "CC" and "CR" combined

CLASS "CWR"
Same as "CW" and "CR" combined

Uses of Class "C" waters:
- Municipal (following complete treatment)
- Aesthetics
- Irrigation
- Stock watering
- Fish propagation
- Wildlife
- Recreation (except swimming)
- Industrial supplies
- Other as determined by Board and Committee

*Dependent on climate
**Maximum Permissible Concentration in water

Plans for Protecting Oil, Gas, and Water Wells and Resources 211.10C (6) xiv

No oil, gas, or water wells exist in the lease area. Water resources are protected by compliance with state and federal water laws and NPDES.

Justification for not Recovering Coal 211.10C (6)xv

Maximum recovery coupled with safety is the object of the overall mine plan.

MAPS 211.10C (7)

211.10C (7)i

Topographic, natural drainage - base Map 1F.

Archeological and cultural features - inventory taken on specific surface projects.

Roads and vehicular trails - base Map 1F.

211.10C (7)ii

Name of watershed - Quitchupah.

Location of receiving stream - Section 211.10C (6)xiii, Plate 3.

211.10C (7)iii

Location and elevations of drill holes - see base Map 1F.

Nature and depth of various strata of overburden - see Map 1A and Lithologic logs in 211.10C (6)xii.

Nature and thickness and extent of any coal - see Map 1F and Confidential suite.

Nature and thickness and extent of rider seams above coal to be mined - none.

Nature of strata beneath coal to be mined - Not applicable.

Location of next known deeper coal seam below coal to be mined - see Map 1F.

Location of any other mineral values encountered - none.

Hydrologic data - See Section 211.10C (6)xiii

Mineral crop lines - Shown on Maps 1A, 1B, 1C.

Strike and dip of coal - Shown on Map 1A, 1B, 1C.

Location and extent of known surface mine workings - Not applicable except for mine facilities shown on Map - Refer to Section 211.10C (IV).

Location and extent of known underground mine workings - Shown on Map 1A, Map 1E.

Location of oil, gas, and water wells within 1/4 mile of affected lands - No known oil, gas, or water wells.

Location of aquifer - Not applicable.

Estimated elevation of water table and patentiometric surface - Not applicable.

Location of:

Spoil - Not applicable.

Waste or refuse area - See Section 211.40A (8).

Topsoil - Not applicable.

Impoundments of water - See Map 1D.

Water treatment - See Map 1D.

Natural or constructed drainways - See Map 1D.

Any discharges - See Map 1D.

Cross sections of final surface - Not applicable.

Location of Surface Structures - Map 1D
211.10C (7)iv

For an Underground Mine (in addition)
211.10C (7)v

Planned mine layout - Shown on Map 1A.

Location and dimension of:

Shafts	N/A
Slopes	N/A
Drifts	Map 1A
Crosscuts	Map 1A
Haulage ways	Map 1A
Air courses	Map 1A
Rooms	Map 1A
Entries	Map 1A
Barrier pillar	Map 1A
Pillar extraction	Map 1C
Subsidence detection grid	Map 1C

211.10C (7)vi

Auguring - Not applicable.

Mine Maps
211.12

Information included on 1" = 400' map of mine workings updated January 1, 1977.

Royalty Maps showing three month progress to be submitted under separate cover.

File/ACT/041/002

COASTAL STATES ENERGY COMPANY

PROPOSED DRILLING PROGRAM

FOR

FEDERAL COAL LEASE SL-062583

SOUTHERN UTAH FUEL COMPANY MINE NO. 1

SEVIER COUNTY, UTAH

AUGUST 1980

Loren A. Williams
Vice President
Resource Acquisition

Coastal States Energy Company

Nine Greenway Plaza
Houston, Texas 77046
(713)877-6408

Subsidiary of
The Coastal
Corporation

August 22, 1980

Mr. Ron Daniels
Division of Oil, Gas & Mining
1588 West North Temple
Salt Lake City, Utah 84116

Dear Mr. Daniels:

Submitted with this letter are seven copies of a proposed 1980 drilling program to be conducted on federal coal lease SL-062583.

An archeological inspection of the proposed drill sites was conducted by Archeological Environmental Research Corporation and the report will be submitted under separate cover.

Sincerely,

Loren A. Williams

Proposed Drilling Program

for

Federal Coal Lease SL-062583

Southern Utah Fuel Company Mine No. 1

Sevier County, Utah

Coastal States Energy Company

August 1980

Table of Contents

EXPLORATION PLAN

1. PROJECT RESPONSIBILITY

Loren A. Williams, Vice President
Resource Acquisition
Coastal States Energy Company
9 Greenway Plaza
Houston, Texas 77046
Phone: 713-877-6408

2. DESCRIPTION

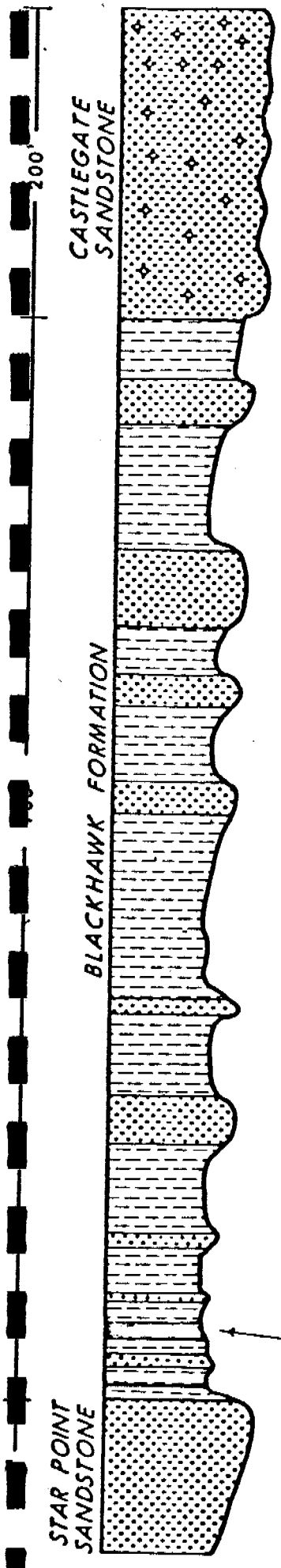
Geology

The coal which is extracted from the Southern Utah Fuel Company (SUFCo) Mine No. 1 occurs in the lower portion of the Blackhawk Formation of the Mesaverde Group of sediments of Upper Cretaceous age. Spieker (1931) identified the seam now mined at SUFCo as the Upper Ivie bed near the present portals. However, Spieker measured numerous outcrops of the same bed in Quitchupah Canyon as the Upper Hiawatha seam, which Spieker (on p. 187) described as the thickest known coal bed in the area. Herein the coal mined at SUFCo is referred to as the Upper Hiawatha seam. The Blackhawk Formation is overlain by the Price River Formation including the Castlegate Sandstone, and is underlain by the Star Point Sandstone, all members of the Mesaverde Group (Figure 1).

The Price River Formation is the youngest or uppermost competent sedimentary unit exposed in the vicinity of the mine. It is the uppermost member of the Mesaverde Group and consists of gray to white sandstone interbedded with subordinate shale and conglomerate. The formation is resistant to weathering and is a ledge and slope former. In the vicinity of the mine it is the uppermost unit capping the surface of the Old Woman Plateau. The formation is reported to be about 550 feet thick near the mine.

GENERALIZED STRATIGRAPHIC SECTION

SL-062583 APPLICATION



LIGHT - GRAY TO WHITE, MEDIUM - TO COARSE - GRAINED SANDSTONE, CONGLOMERATIC IN PART

MEDIUM - GRAY TO BLACK SHALE, SILTY SHALE, AND CLAYSTONE, WITH ABUNDANT LIGHT - GRAY, VERY FINE - TO MEDIUM - GRAINED SANDSTONE BEDS AND LENSES, AND SPARSE MEDIUM - GRAY, THIN - BEDDED SILTSTONE

UPPER HIAWATHA SEAM

AVERAGES 15 FEET IN THICKNESS, THICKER TOWARDS THE NORTHWEST AND THINNER TOWARDS THE SOUTHEAST.

Bottom Of Seam 20 Feet To 40 Feet Above Top Of Star Point Sandstone

LIGHT - GRAY TO WHITE, VERY FINE - TO MEDIUM - GRAINED, BURROWED SANDSTONE WITH SORTINGS AND GRAIN SIZE INCREASING UPWARDS

Figure 1

The Castlegate Sandstone, the basal member of the Price River Formation, is a massive, cliff-forming, white to gray, coarse-grained sandstone, often conglomeratic, and which weathers brown. It overlies the Blackhawk Formation and is reported as being 90 to 200 feet thick (Doelling). The Castlegate Sandstone, together with the other beds of the Price River Formation, constitutes the cap rock which forms the mesa and plateau landforms in the area of the Southern Utah Fuel property.

The Blackhawk Formation, according to Doelling, consists of "yellow to gray, fine to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale (and having) several thick coal seams." Doelling's measured section of the Blackhawk Formation measured in Quitchupah Canyon in the SE¼, NE¼ of Section 8, Township 22 South, Range 5 East as having a thickness of about 670 feet. In this section, the Upper Hiawatha (Ivie) bed lies about 50 feet above the base of the Blackhawk.

The Blackhawk Formation is underlain by the Star Point Sandstone, also of the Mesaverde Group. The Star Point Sandstone is reported by Doelling as consisting of a "yellow-gray, massive cliff-forming sandstone often in several tongues separated by Masuk Shale." The Star Point Sandstone is from 200 to 300 feet thick near the mine.

Generally, the sediments have a strike which trends roughly northeast and a shallow dip of about 250 feet per mile to the northwest. Several small faults, most of which have an apparent vertical

displacement of about three feet or less, have been encountered in the mine workings. One fault has an 8' displacement. These faults have a trend of about N 10 to 15 degrees W and are near vertical. A joint set occurs parallel to the fault trend and another bears a normal or conjugate relationship. It is along these faults that much of the underground seepage of water is encountered.

Water

Surface drainage from the lease area comprises East Spring Canyon and the eastern extremities of Mudspring Hollow.

Hydrology of the area is covered comprehensively in the Mine Plan submitted by Coastal States to the USGS, February 12, 1977, as amended.

Vegetation

Vegetation changes from one landform to another. On the benches, there is a combination of sagebrush-grass community and ponderosa pine strands. Also occurring intermixed in these types are patches of low quality Quaking Aspen, Mountain Mahogany, and Manzanita brush. Ground cover is composed of several native grasses, forbs, and low brush species. Density is generally good.

The steep slopes and scarp faces are sparsely vegetated. Pinyon, Juniper, and Mountain Mahogany are scattered over the landform. The site is very harsh and ground vegetation is limited to light quantities

of native grasses and forbs in cracks and shelves where soil can accumulate. Composition includes a few drought resistant grasses, annual forbs, Mountain Mahogany and other brush.

Narrow stringers in the canyon bottoms are the most productive landform in the area. Vegetation is primarily native grass, low brush and forbs growing together to form a heavy sod. Brush types include willow, rose, rabbit brush, sand brush and others. Carex grows in some of the wetter spots. Only an occasional tree occurs in the bottom.

The rolling hills are covered by an occasional small patch of trees which include Ponderosa Pine, Douglas-fir, Alpine-fir, Spruce and Aspen. More common are brush species including oak, snowberry, and sagebrush. Grasses and forbs are very sparse and include several native species.

No threatened or endangered plants are known to occupy the leasehold area.

Wildlife

The lease has a component of animals common to the Old Woman Plateau. Those for which impacts may occur are few. Bald eagles have been observed. It is believed they winter in the steep slopes and scarp faces on the eastern edge of the lease. Mule deer use the area for summer range. Elk winter in the lease area. Black bear, coyote and mountain lion are present. The intermittent flow of streams

is not capable of supporting fishlife. The only rare and endangered species that occurs is the bald eagle.

Landuse

The surface area is grazed by cattle under the Quitchupah C and H allotment. The allotment is under an intensive rest-rotation management system. Several ranchers in Emery are dependent on the allotment. Structural range improvements include one watering trough and two cattle guards on the access route into the lease. Water in the trough is supplied by a spring.

Recreation is primarily big game hunting. It is light, occurring over a month's period of time each year. Snowmobiling also occurs.

The timber on the lease area is open grown Ponderosa Pine. All commercial stands occur on the benches. Trees are of low quality because of the poor tree growing site. Cutting is limited to older, over-matured trees.

Land use in the surrounding area is covered comprehensively in the U.S. Forest Service Report, Final Environmental Statement for Land Use Plan - Salina Planning Unit.

3. DRILLING OPERATIONS

The drilling program on Federal Coal Lease SL-062583 (proposed locations plotted on Plate 1) as outlined in this report is undertaken to provide quantitative and qualitative hydrologic data on the

Castlegate Sandstone Member of the Price River Formation. Two (2) holes are planned, but six (6) will be permitted for flexibility. Coastal States Energy feels this program will accomplish the above-mentioned objectives and that the operations planned are necessary for an effective water monitoring program. The program has been designed with full consideration for the surface lands and will be carried out in such a manner as to assure minimal permanent surface disturbance. An attempt has been made to locate drill holes along existing roads where possible. Drill sites which require road work are located and designed to minimize excavation and disturbance of vegetation.

It is anticipated that one drilling rig will be contracted from a reputable firm. Drill sites will be prepared in the following manner. Sagebrush or other vegetation presenting a fire hazard will be cleared in an area approximately 40 feet by 60 feet. This area will accommodate the drilling rig, drill service vehicle, water truck, logging truck and vehicles for transporting drilling and supervisory crews. At each site, a mud pit of a size adequate to contain cuttings and drilling fluid will be dug. Topsoil will be stockpiled separately.

Holes will be completely cased and capped for monitoring. Casing will proceed as follows. A 10 1/2 inch hole opener will drill through the alluvium and any surface water. A 10 1/2 inch casing will be set and grouted, then a smaller hole (about 7 1/2 inch) will be drilled through the Castlegate and 6 5/8 to 7 inch diameter casing will be

set for the entire length of the hole. Drilling will be done with air until wet sand is encountered, then air mist injection will be used. If necessary, water will be hauled, from an approved source, by truck.

Use of air-mist injection will minimize water usage and will also minimize water truck travel on location roads.

Drill water economy cannot be estimated at this time. Drilling mud will be used only in the event of circulation problems.

Protection of the Environment

The preservation of the environment will be taken into account through all phases of this drilling program. All drill sites are planned to minimize disturbance to the terrain. Pits will be used to contain all water and mud used in drilling. These drilling fluids will not be allowed to run into the stream drainages.

Throughout all phases of this drilling program, the district ranger's office of the Fishlake National Forest will be informed of all drilling and reclamation progress.

It is the policy of Coastal States Energy Company to reclaim all drill sites and associated roads to the same condition, or in some cases, better condition than they were prior to drilling. During this drilling program and in the future, all feasible precautions will be taken in order to protect all aspects of the environment in

the region.

Air Pollution - No burning will be allowed.

Wildlife - Drilling operations will be curtailed from November 1 through April 1 to avoid interfering with wintering elk.

Other Resources - No producing oil, gas, or water wells exist in the lease area.

Public Health & Safety - Drilling operations will be conducted in a safe and efficient manner, minimizing the contact with the public and environment.

Laws and Regulation - Responsibility lies within Coastal States Energy Company to comply with all regulations of the BLM, USGS, Forest Service and State of Utah and to assure that contractors and subcontractors know and understand the exploration plan and its stipulations. Sundry notices will be submitted to the USGS in a timely manner after exploration is completed.

Surface Reclamation

Reclamation will be performed contemporaneously with drilling to the extent feasible.

Upon completion of drilling and testing, the holes will be capped with a steel cap on a hinge. A padlock will be used to secure the

cap. The casing will protrude above the ground surface no more than one foot. The site will be cleaned and all material foreign to the natural setting will be buried or removed. Liquids in the pits will be allowed to evaporate or will be spread on approved roads. The pit will be filled with the stockpiled soil. The area will be raked with a power rake and the seed mixture will be sown with a hand spreader. Seed will be buried by a drag attached to a pickup. Since drilling will take place during the dry summer months, seeding will be postponed until the fall season. No fertilizer will be applied to avoid attracting animals to a greener patch.

Seed Mixture and Density

Crested Wheatgrass - Fairway Strain	- 4# per acre
Sodar Streambank Wheatgrass	- 4# per acre
Hard Fescue (Durar)	- 4# per acre
Ladak Alfalfa (innoculated)	- 2# per acre
	14# per acre

4. ESTIMATED TIME TABLE

The archeological survey will be conducted in early August 1980.

The drilling program would begin on September 1, 1980 (or earlier with Forest Service approval) and be completed by September 15, 1980, depending on the date that drilling equipment becomes available. It is estimated that no more than three days will be required for any one drill site. A list of hole locations and depths is given in Table 1.

TABLE 1

Hole #	Location (T21S, R4E, SLM)	Elevation	Total Depth
US-80-1	Sec. 36: NW¼ SW¼ SE¼	8380	180'
US-80-2	Sec. 36: NE¼ SE¼ SW¼	8360	170'
US-80-3	Sec. 36: SW¼ SE¼ SE¼	8380	170'
US-80-4	Sec. 36: SW¼ NE¼ SE¼	8380	190'
US-80-5	Sec. 36: NE¼ SE¼ SE¼	8380	170'
US-80-6	Sec. 36: SE¼ NE¼ SE¼	8370	175'

References

Doelling, H.H., 1972, Central Utah Coal Fields: Sevier - Sanpete, Wasatch Plateau, Bookcliffs and Emery, Utah Geological and Mineralogical Survey Monograph Series, No. 3.

Spieker, E.M., 1931, The Wasatch Plateau Coal Field Utah, U.S. Geological Survey Bulletin 819.

ALTERNATE # 1

DRAINAGE FACILITIES

AND

SEDIMENT CONTROL PLAN

SOUTHERN UTAH FUEL COMPANY

MINE NO. 1

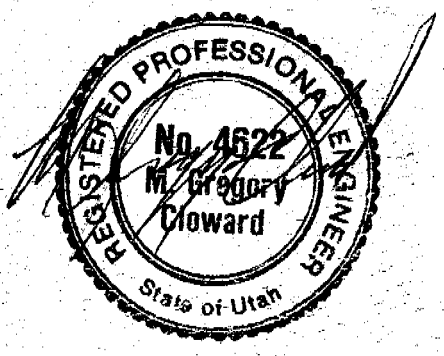
June 11, 1980

Prepared For

SOUTHERN UTAH FUEL COMPANY

P.O. BOX P

Salina, Utah 84654



Prepared By

Daley Engineering, Inc.

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June 11, 1980

Kerry Frame
Chief Engineer
Southern Utah Fuel Company
P.O. Box P
Salina, Utah 84654

Dear Kerry:

Submitted herewith is the report, concept plans, calculations, and drawings for Alternate # 1 to the present Drainage Plan which was submitted to you by Merrick and Company, Engineers and Architects of Denver, Colorado.

The proposed Alternate deals with a relocation of the sedimentation pond to the area immediately below the fill on which existing mine facilities are constructed. This plan also includes a new concrete sedimentation basin which will remove in excess of 65% of all solids before runoff from the disturbed area enters the sediment pond. This allowed us to reduce the size of the sediment pond as outlined in the regulations and to decrease the amount of overall disturbance. We feel that this alternate is more efficient in removing and controling sedimentation and controling drainage, as well as being more economical and fitting in more readily with the overall reclamation plan for Mine # 1.

Much of the original hydrologic and hydraulic information has been taken from the report by Merrick and Company dated September 17, 1979, where applicable. Notations for drainage basins, such as ATOF and SOF are described in Merrick's Report. We have not attempted to reiterate calculations and information that are detailed in their report, and some familiarity with Merrick's Report is necessary to adequately understand the information given here.

Sincerely,

M. Gregory Cloward, P.E.

DESCRIPTION OF PROPOSED ALTERNATES

Alternate # 1, to the drainage and sedimentation plan prepared by Merrick and Associates, primarily involves relocation of the sedimentation pond, and enlargement and redesign of the existing concrete sedimentation basin on top of fill slope near the existing crushing operation.

The primary drainage plan as outlined by Merrick will be used with this alternate. The 72" CMP which collects water from East Spring Canyon and Mud Spring Hollow will be reduced to a 48" pipe on the steep fill slope below the mine facility area. This 48" pipe will run underneath the proposed dam and empty water from above the disturbed area into the existing drainage. The water from the existing sedimentation tank, which currently connects and empties into the 72" pipe, will be diverted to a newly constructed 24" pipe and run down into the new sediment pond. The sediment pond will be located immediately below the toe of the existing fill, as shown on Sheet 2 of the enclosed drawings. The sedimentation pond in conjunction with the concrete sediment basin located on top of the fill are adequately sized to handle all runoff and sediment volume for a 10-year 24-hour storm event.

The spillway has been designed to handle a 100-year 24-hour event. The primary outlet has been designed to drain the 10-year 24-hour storm in 24 hours, and has been equipped with a grease and oil skimmer. Concrete cutoff collars have been designed and placed on the 48" pipe that passes underneath the dam and on the 12" primary outlet pipe. An energy dissipater has been designed to be placed at the toe of the spillway for erosion and channel protection.

A riprap and gravel filter slope drain has been designed to protect the toe of the existing fill from erosion or movement as a result of having a saturated toe caused by water in the sediment pond. The slope drain allows for free movement of water from the existing fill material for good drainage without permitting a migration of soil material. The slope drain also acts as ballast to further insure slope stability.

The dam will be keyed into competent rock with abutments in the fine grain massive sand stone, known as the Star Point Formation.

Material for construction of the dam will conform to U.S. Bureau of Reclamation standards for design of small dams, and will be obtained locally from previously disturbed areas. Riprap for the project will be collected on the dam site location. Gravel and filter material will be imported from the Salina area.

As can be seen on Sheet # 1 of the drawings, the dam will be located in a drainage which has very little impact, should the structure fail, on any downstream facilities. The Quitchupah Creek drainage runs under Utah Highway 10, and continues eastward into the Colorado River Basin Drainage. There are no houses, buildings, or structures which can be affected should the dam fail. All significant hydraulic structures and earthwork structures have been designed with a minimum 1.5 to 1 safety factor.

The concrete sedimentation basin on top of the hill has been designed to remove a minimum of 65% of the total sediment volume which is created from the basin designated by Merrick as ATOF, which is primarily the disturbed area around the mine portal facilities and crusher area. The structure will remove more than 65% of the sediment material as low flows expected under normal runoff conditions, and storms smaller than the 10-year 24-hour event.

As mentioned in the attached cover letter, sedimentation volumes and runoff volumes were taken from the report by Merrick. The design of these facilities has been based on that work. One distinct advantage of locating a sediment pond at the location described in this alternate, is that it is compatible with the overall final reclamation plan. The downstream 2 to 1 slope will be continued upstream towards the portal facilities during final reclamation, and the spillway will also be continued up this 2 to 1 slope to become the permanent stream channel upon final reclamation. This means that facilities that are now constructed are compatible and will be compatible with final reclamation and will not need to be removed, but rather a small amount of additional grading and contouring to blend with the final grading plan is all that will be necessary. This enhances and creates a minimal amount of disturbance as opposed to locating the structure farther downstream.

OK Flannery Decision

An access road will be constructed down to the pond as shown on Sheet # 2, and will have a maximum 15% slope. This will allow for cleaning and maintenance of the pond.

2 not for more than 1000' max avg all 10%

CLASS II or CLASS II ?

The complete plan set showing details and design of all structures associated with this alternate has been included. These plans are in final form for approval with exception that some information necessary to the selected contractor and for his benefit such as structural detailing and contract documents will be prepared upon approval by the reviewing agencies of this concept plan. Hydrologic and hydraulic calculations are included in this report and follow here:

CALCULATIONS

POND SIZING

Total Runoff Area

ATOF = Area top of fill = 12.0 acres

SOF = Area slope of fill = 95,000 sq. ft. = 2.2 acres

Use 2.5 acres " from Merrick Report

Runoff volume .10 acre @ 1.9 cfs

Sediment volume = .25 ac. ft.
CBW = Contributing Basin west = .51 acre feet

Runoff Volume =	.49	ac. ft.	ATOF
	.25	ac. ft.	SOF
	.51	ac. ft.	CBW
	1.25	Total Runoff Volume	

Sediment Volume
(Reduce volume from ATOF by 65% due to concrete settling basin. See page 10).

	.25		SOF
.35 x 1.2	=.42		ATOF (From Merrick)
	.67	Total Sediment Volume	

Pond Volume = 1.25 + .67 = 1.92 ac. ft.

It is proposed to:
Reduce sediment volume by 50% by cleaning when sediment volume reaches 60% of total volume.
Reduce sediment volume to .34 ac. ft.
Total 10 year pond volume = 1.25 + .34 = 1.59 ac. ft.

Elev.	Area (Sq. Ft.)	Volume (Ac. Ft.)
7718	9720	
		.22
7417	8577	
		.35
7415	6813	
		.61
7410	3807	
		.32
7405	1728	
		.12
7400	369	

Total Volume Available = 1.62 Ac. Ft.

Spillway Design

Design @ 100 years 24 peak = 62.4 cfs x 1.5 S.F. = 94 cfs

$Q = CLH^{3/2}$ C = 3.0 H = 2.0 feet L = 11.08 feet

Check Manning

$$Q = \frac{1.49}{n} AR^{2/3} S\ 1/2 \qquad n = .045$$

$$Q = \frac{1.49}{.045} (22.16) \left(\frac{22.16}{15.08}\right)^{2/3} (1/2)^{1/2}$$

Q = 670 cfs OK

Pipe Sizing

Mud Spring Hollow = 147 cfs

East Spring Canyon = 247 cfs

Mine Flow = 5 cfs

Total 399 cfs Say 400 cfs

$S = \frac{120}{175}$ on steep slope

Try 48" on steep slope

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

n = .027 A = 12.57 S.F. R = 1 S = .69

$$Q = \frac{1.49}{.027} 12.57 (1)^{2/3} (.69)^{1/2} = 576 \text{ cfs} \quad \text{OK}$$

Try 42" on steep slope A = 9.62 R - .875

$$Q = \frac{1.49}{.027} (9.62)(.875)^{2/3} (.69)^{1/2} = 403 \text{ cfs} \quad \text{OK}$$

Try 48" for overall length = 495

$$Q = \frac{1.49}{n} AR^{2/3} S\ 1/2$$

$$= \frac{1.49}{.027} (12.57)(1)^{2/3} (.35)^{1/2}$$

= 410 cfs - Good - Use 48" pipe velocity = 32.63

Use heavy gauge for scour protection

Check Entrance loss from 72" to 48"

$h_e = k_e \frac{V2}{29}$ Assume $k_e = .5$

$h_e = .5 \frac{(\frac{410}{12.57})^2}{64.4} = 8.26$ feet

Try 10' of 72" at S = .54

L = 18.51' say 20'

$410 = \frac{1.49}{.027} (36) (1.5)^{2/3} (\frac{hL}{20})^{1/2}$

$h_L = .50'$

$h_{L_t} = .5 + 8.26 = 8.76$ feet

Use 20 of 72" down slope with tentle transition

Pond Outlet Q 10 = 20.6 $Q_{p\ 25}$ = 36.3 cfs

Q_{25} = .72 + .15 + .85 + .07 = 1.79 ac. ft./24 hrs. = .90 cfs

Use 1.5 SF Q = 1.35 cfs

Try 12" pipe L = π D = 3.14'

Q/ft. = .43 cfs/ft.

from table 20-17 Seelye

H = .24' 12" acceptable

Top of Slope Inlet (After Merrick)

Existing inlet HW = 18"
Q = 23.2 cfs, Not enough head available

Try new 24" Dia CMP

Orifice Control
HW req = 1.14 ft. = 14", Good
Inlet Control (at bend)
HW req = 2.8 ft. = 34", Good

Pipe Sizing Along Slope

Shallowest slope 0.05
Use unpaved CMP 2-2/3 x 1/2 Corrugations
n = .024
Q = 23.2 cfs

$$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$$

Size	A	R	Q		
18	1.77	0.375	15.5	No Good	
24	3.14	0.50	27.5	Good	V = 8.75 fps
21	2.41	0.44	19.3	No Good	
Q/Q Full = .84		V = 9.8 fps		D = 1.23 ft.	

S	Q Cap	V Cap	Q/Q Cap	V	d
0.215	52.3	16.6	0.44	9.4	0.92
0.135	41.4	13.2	0.56	13.5	1.06
0.120	39.1	12.4	0.59	12.9	1.10

Cutoff Collars

L = 289'
S = .24
Y = 4'
Z = 3'

L_{rt} L_5 = 1.25 L = 361.25

collar length - 72.25' L = L_5

Use 8 collars @ 4' x 1' above pipe

Riprap Sizing in East Spring Canyon (After Merrick)

V_b = 9.81 (based on velocity and depth in natural stream)

D_{50} req = 15" Class II riprap

Filter Sizing

Existing Soil

d_{85} = 0.47 mm

d_{50} = 0.135 mm

3_{15} = 0.017 mm

Filter Layer 1

$DF_{1\ 15}$	$5d_{85}$	$DF_{1\ 15}$	1.85 mm	$DF_{1\ 15}$	= 0.55 mm
$DF_{1\ 15}$	$5d_{15}$	$DF_{1\ 15}$	0.085 mm	$DF_{1\ 50}$	1.50 mm
$DF_{1\ 50}$	$25d_{50}$	$DF_{1\ 50}$	3.38 mm	$DF_{1\ 85}$	3.50 mm
$DF_{1\ 15}$	$40d_{15}$	$DF_{1\ 15}$	0.68 mm		

Filter Layer 2

$DF_{2\ 15}$	17.50 mm	$DF_{2\ 15}$	= 7.0 mm
$DF_{2\ 15}$	2.50 mm	$DF_{2\ 50}$	= 23.0 mm
$DF_{2\ 50}$	37.50 mm	$DF_{2\ 85}$	= 55.0 mm
$DF_{2\ 15}$	20.00 mm		

Riprap Limits

RR_{15}	275 mm
RR_{15}	35 mm
RR_{50}	575 mm
RR_{15}	280 mm

Energy Dissapater for 24" Pipe

Q = 23.2 cfs in 24" Dia CMP
S = 51% Down Face of Slope
S - 15% Final 30' into stilling basin

$Q\ Cap = \frac{1.49}{n} AR^{2/3} S^{1/2}$ n = 0.027 A = 3.14 SF R = 0.5 feet S = 0.15

Q Cap = 42.3 cfs V Cap = 13.5 fps
Q/Q Cap = .55 V = 13.9 fps y = 1.1 ft.

Froude number = $V/\sqrt{gd}$
where $V = \sqrt{2gh}$
g = acceleration of gravity
h = head loss required
d = A
$V = \sqrt{2g\ (4.1)} = 16.2$

$\sqrt{gd} = \sqrt{g(1.77)} = 7.6$

F = 2.15
W/d = 4.4
W = 7.8 ft = use W = 8 ft.

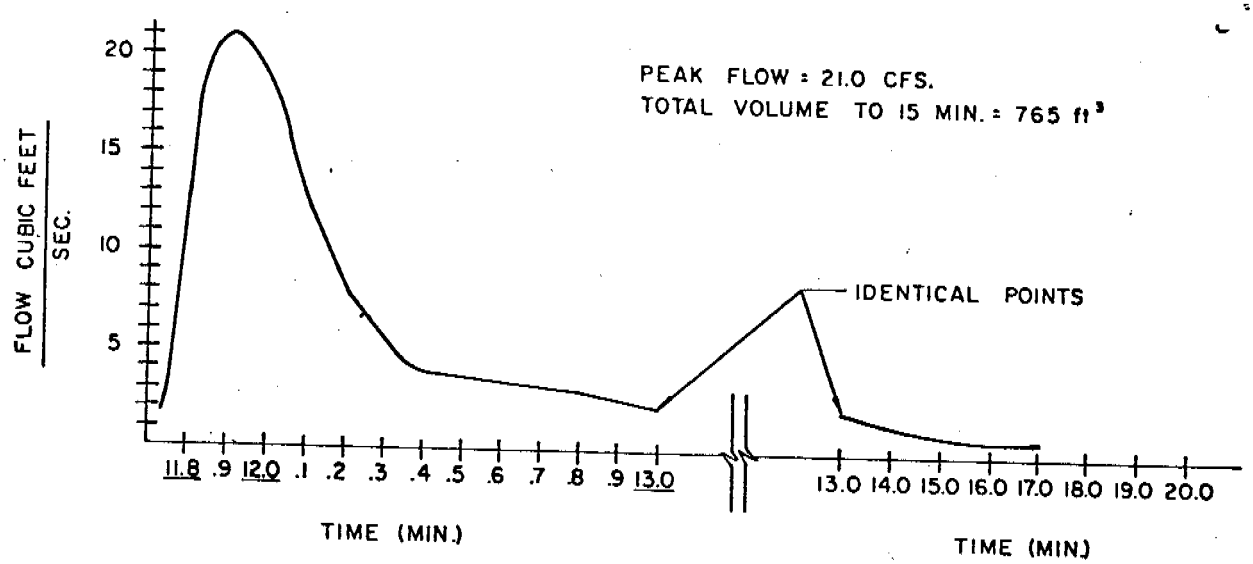
CONCRETE SEDIMENTATION BASIN

SOUTHERN UTAH FUEL COMPANY
SALINA UTAH

DESIGN STORM VOLUMES:

For a 10-year 24-hour storm the water reaching the sedimentation basin prior to 15 min. after the storm beginning, based on the Hydrograph computed by Merrick and Companies 765 ft^3.

If a basin of 1900 ft^3 of volume is used and assumed to be nearly empty when the storm began, the average over flow from the basin will be about 0.57 c.f.s. during a 10-year 24-hour storm.



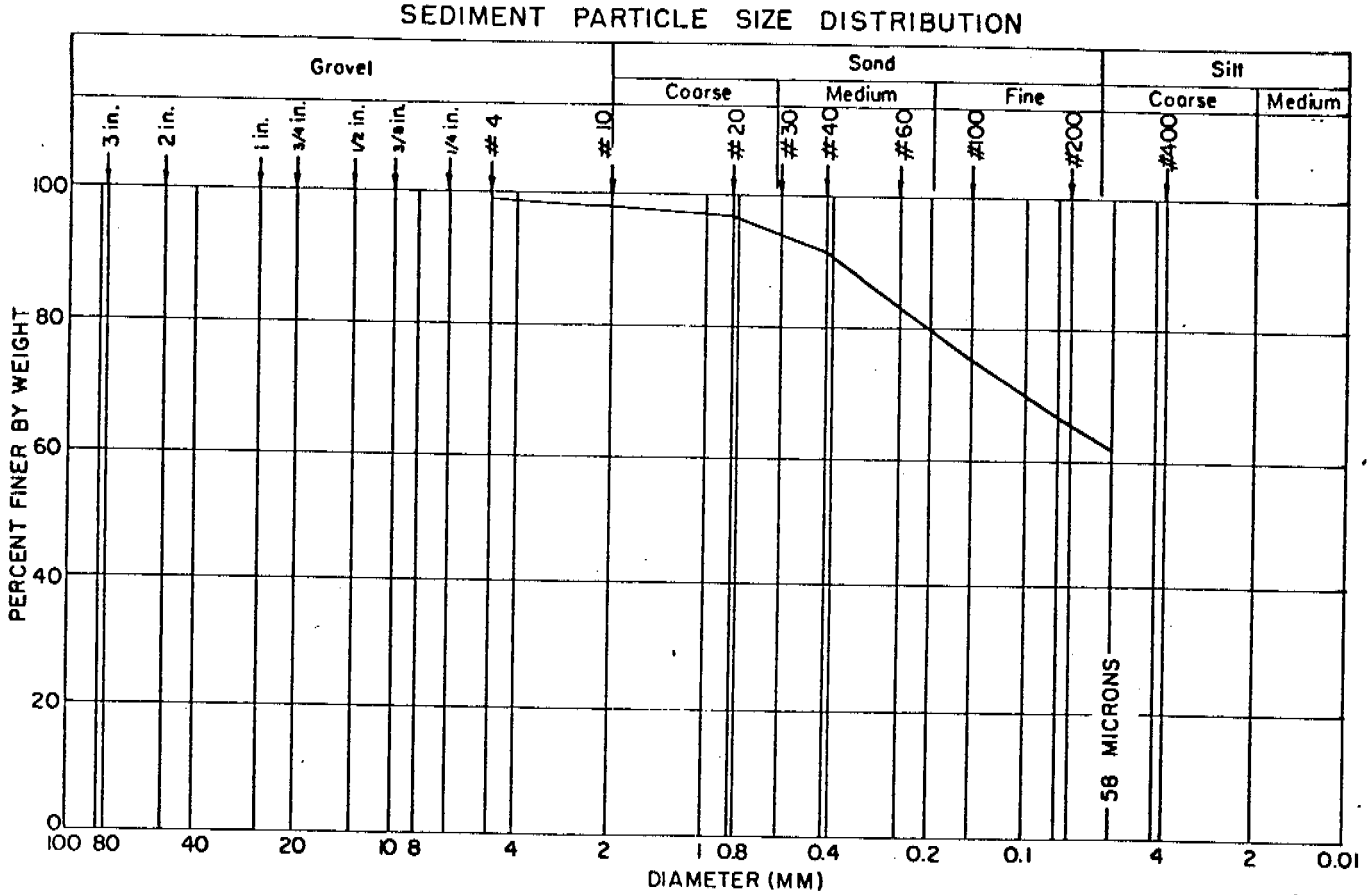
HYDROGRAPH AT SEDIMENTATION BASIN FOR 10 YEAR 24 HOUR STORM

At this flow rate of 0.57 cfs, which will be the average loading rate for the design storm, an effective detention time of 1053 seconds will exist when the tank is all but 1 foot full of settleable solids. This will remove all particules larger than .58 microns according to Stokes Law.

$$Vs = \frac{g}{18} \frac{(Ss - Sw)}{K} d^2$$

Where Vs = Settling velocity of solid.
g = 32.2 ft/sec^2
Ss = specific gravity of solid = 2.48 for coal
Sw = specific gravity of water 1.94
d = diameter of solids
K = dynamic visocity

The following table shows graphic results of a sieve analyses of typical sediment collected from the existing sedimentation basin.



As can be noted from the sieve analysis this amount to 39% removal of the material entering the tank.

Because some settling in the concrete basin will be Class 2 sedimentation, which occurs when small particles attach themselves to large particles by surface tension, the actual volume to be settled out will be considerably higher than that indicated by Stokes Law.

To determine the amount of actual removal a laboratory test was run. 75 ml of sample sediment was placed into a settlemeter then diluted and suspended in cold water. Following the prescribed time period of 1053 seconds, the water was decanted from the settlemeter and about 50 ml of soil mass was recovered. This indicates a 66% removal rate based on volume.

It should be pointed out that this is based on the detention times for the design storms and in actual use the removal rate from the concrete basin would be larger because of the longer detention times that will exist with smaller magnitude storms which occur most frequently.

Larger removal rates into the concrete sedimentation basin can be accomplished by the addition of alum to the water flowing into the sedimentation basin or placing it directly into the basin. Further laboratory testing showed that 95% of the sediment volume could be removed during the 1053 second detention time if alum is used to floculate the smaller solids. It is recommended that this procedure be used for smaller storms and to settle the solids from the liquid within the tank prior to decanting the tank following any storm.

In the laboratory test 1.5 grams per liter or about 180 # for the tank volume produced good settling rates. To determine the best dosage for field conditions other dosages should be tried.

The sedimentation tank is designed to handle a peak hydraulic flow of 21 cfs throughout the tank and draining the entire flow into the 24 inch diameter outlet pipe.

COASTAL STATES ENERGY COMPANY

PROPOSED DRILLING PROGRAM

SOUTHERN UTAH FUEL COMPANY PROPERTY

Loren A. Williams
Vice President
Resource Acquisition

Coastal States Energy Company

Nine Greenway Plaza
Houston, Texas 77046
(713)877-6408

Subsidiary of
The Coastal
Corporation

March 25, 1981

Mr. Jackson W. Moffitt
Area Mining Supervisor
Branch of Mining Operations
U.S. Geological Survey
Room 8426, Federal Building
Salt Lake City, Utah 84111

Dear Mr. Moffitt:

Re: Federal Lease U-47080 (SUFCo)

Submitted with this letter are eight copies of a proposed drilling program to be completed during the summer of 1981 on Federal Lease U-47080. We request your approval of this program.

This permit application is submitted with the understanding that approval will be contingent upon Coastal States Energy Company acquiring Federal Lease U-47080 at an Emergency Lease Sale to be held during the spring of of 1981. Drilling will be completed under the supervision of myself and Coastal personnel based in our Salt Lake City office.

Sincerely,

Loren A. Williams

LAW:dh

NOTICE OF INTENT TO EXPLORE

Proposed Drilling Program

for

Coal Lease U-47080

SOUTHERN UTAH FUEL COMPANY MINE NO. 1

Sevier County, Utah

Coastal States Energy Company

March, 1981

This application is submitted pursuant to the Utah Division of Oil, Gas and Mining's Coal Mining and Reclamation Permit Program, specifically Section UMC 776, USGS regs 30 CFR 211:10, OSM regs 30 CFR-776.

Person Seeking to Explore:

L. A. Williams, Vice President
Resource Acquisition
Coastal States Energy Company
Nine Greenway Plaza
Houston, Texas 77046
(713) 877-6408

Person Responsible for Exploration Activities:

Larry M. Trimble, Geologist
Coastal States Energy Company
411 West 7200 South
Midvale, Utah 84047
(801) 566-7111

TABLE OF CONTENTS

DESCRIPTION

Geology

Two geologic formations are exposed in Lease U-47080; the Tertiary North Horn Formation (exposed at the top of Duncan Mountain) overlying the Upper Cretaceous Price River Formation. Units which are not exposed on the lease, but which are present in the sub-surface and are important to this project are the Castlegate Sandstone, Blackhawk Formation, and Star Point Sandstone.

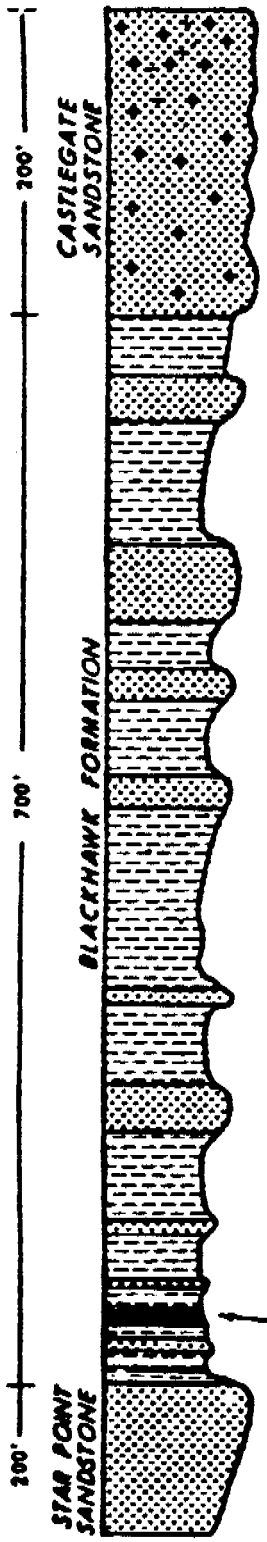
The coal in Lease U-47080 is the Upper Hiawatha seam which is extracted from Coastal States Energy Company's SUFCo No. 1 Mine and occurs in the lower portion of the Blackhawk Formation of the Mesaverde Group of sediments of Upper Cretaceous age. The Blackhawk is overlain by the Star Point all being members of the Mesaverde Group (Figure 1).

The Price River Formation is the uppermost member of the Mesaverde Group and consists of gray to white sandstone interbedded with subordinate shale and conglomerate. The formation is resistant to weathering and is a ledge and slope former. In the vicinity of the mine it is the uppermost unit capping the mesa which forms the Old Woman Plateau. The formation, exclusive of the Castlegate Sandstone, is reported to be about 450 feet thick on Duncan Mountain.

The Castlegate Sandstone is a massive, cliff-forming, white to gray, course-grained sandstone, often conglomeratic, and which weathers brown. It is considered as the basal member of the Price River Formation. It overlies the Blackhawk Formation and is reported as being 90 to 200 feet thick (Doelling). The Castlegate Sandstone, together with the other beds of the Price River Formation, constitutes the cap rock which forms the mesa and plateau landforms in the area of the Southern Utah Fuel Property.

GENERALIZED STRATIGRAPHIC SECTION

Lease U-47080



LIGHT - GRAY TO WHITE, MEDIUM - TO COARSE - GRAINED SANDSTONE, CONGLOMERATIC IN PART

MEDIUM - GRAY TO BLACK SHALE, SILTY SHALE, AND CLAYSTONE, WITH ABUNDANT LIGHT - GRAY, VERY FINE - TO MEDIUM - GRAINED SANDSTONE BEDS AND LENSES, AND SPARSE MEDIUM - GRAY, THIN - BEDDED SILTSTONE

UPPER HIAWATHA SEAM

AVERAGES 9 FEET IN THICKNESS, THICKER TOWARDS THE NORTHWEST AND THINNER TOWARDS THE SOUTHEAST.

Bottom Of Seam 20 Feet To 40 Feet Above Top Of Star Point Sandstone

LIGHT - GRAY TO WHITE, VERY FINE - TO MEDIUM - GRAINED, BURROWED SANDSTONE WITH SORTINGS AND GRAIN SIZE INCREASING UPWARDS

Figure 1

The Blackhawk Formation, according to Doelling, consists of "yellow to gray, fine to medium-grained sandstone, interbedded with subordinate gray and carbonaceous shale (and having) several thick coal seams." Doelling reports a section of the Blackhawk Formation measured in Quitchupah Canyon in the SE-1/4 of Section 8, Township 22 South, Range 5 East as having a thickness of about 670 feet. In this section, the Upper Hiawatha bed lies about 50 feet above the base of the Blackhawk.

The Blackhawk Formation is underlain by the Star Point Sandstone, also of the Mesaverde Group. The Star Point Sandstone is reported by Doelling to consist of a "yellow-gray, massive cliff-forming sandstone often in several tongues separated by Masuk Shale." The Star Point Sandstone is from 200 to 300 feet thick in the vicinity of the mine.

Generally, the sediments have a strike which trends roughly northeast and a shallow dip of about 250 feet per mile to the northwest. Several small faults, most of which have an apparent vertical displacement of about three feet or less, have been encountered in the mine workings. One fault has a displacement of eight feet. These faults trend approximately N 10 to 15 degrees W and are near vertical. A joint set occurs parallel to the fault trend and another bears a normal or conjugate relationship. It is along these faults that much of the underground seepage of water is encountered. This structure has not significantly affected mining but ultimately may have an adverse affect on total coal recovery.

Water

Surface drainage from the lease area comprises the north end of East Spring Canyon and tributaries to the south fork of Quitchupah Creek. The Castlegate Sandstone Member of the Price River Formation will be penetrated by drilling and may be water-bearing on the lease.

Vegetation

Vegetation appears to be related to type of landform. On the benches landform there is a combination of sagebrush-grass community and ponderosa pine stands. Also occurring intermixed in these types are patches of low quality Quaking Aspen, Mountain Mahogany, and Manzanita brush. Ground cover is composed of several native grasses, forbs, and low brush species. Density is generally good.

The rolling hills landform is covered by an occasional small patch of trees which include Ponderosa Pine, Douglas-fir, Alpine-fir, Spruce and Aspen. More common are brush species including oak, snowberry, and sagebrush. Grasses and forbs are very sparse and include several native species.

Wildlife

The lease area could potentially be inhabited by about 102 avifauna, 59 mamalian, 6 amphibian and 16 reptilian species. There are no threatened or endangered species of non-avian vertebrates inhabiting or known to have inhabited the area in the recent past. The only threatened or endangered avian species that may occur in the area would do so only briefly during migration.

The portion of Duncan Mountain used by elk as calving ground would not be occupied by drilling equipment during the calving season. A more complete discussion of wildlife in the project area may be found in White (1980) and Smith (1980).

Landuse

The surface area is grazed by cattle. The allotment (from the Fishlake National Forest) is under an intensive rest-rotation management system. Several ranchers are dependent on the allotment.

Recreation primarily consists of seasonal big game hunting. It is light, occurring over a month's period of time each year. Snowmobiling also occurs.

The timber on the lease area is open grown Ponderosa Pine. All commercial stands occur on the benches. Trees are of low quality because of the poor tree growing site. Cutting is limited to older over-matured trees.

Landuse in the surrounding area is addressed in the U. S. Forest Service Report, Final Environmental Statement for Land Use Plan - Salina Planning Unit.

DESCRIPTION OF EXPLORATION AREA

Statement Describing Lands Included in this application for coal lease

The legal description of the lands included in this application for coal lease is as follows:

T. 21S., R. 4E., Salt Lake Meridan, Utah

Section 25: all

Section 36: N-1/2

T. 21S., R. 5E., Salt Lake Meridan, Utah

Section 30: Lots 2, 3, & 4, W-1/2 SE-1/4

Containing 1,160 acres, all in Sevier County, Utah

DRILLING OPERATIONS

The drilling program on Federal Coal Lease U-47080 (proposed locations plotted on Plate 1) as outlined in this report is undertaken to provide quantitative and qualitative geologic data on the Upper and Lower Hiawatha coal seams in the Blackhawk Formation. Four (4) holes are planned. Coastal States Energy feels this program will accomplish the above-mentioned objectives, and that the operations planned are necessary for the development of an efficient mining plan for the lease. The program has been designed with full consideration for the surface lands and will be carried out in

such a manner as to insure minimal permanent surface disturbance. An attempt has been made to locate drill holes along existing roads where possible. At those locations where road work is necessary, it has been designed to minimize excavation and disturbance of vegetation.

It is anticipated that one drilling rig will be contracted from a reputable firm. Drill sites will be prepared in the following manner: Any sagebrush or other vegetation presenting a fire hazard will be cleared in an area approximately 40 feet by 60 feet. This area will accommodate the drilling rig, drill service vehicle, water truck, logging truck and vehicles for transporting drilling and supervisory crews. At each site, a mud pit of a size adequate to contain cuttings and drilling fluid will be dug. Topsoil will be stockpiled separately.

Holes will be cased to the Castlegate Sandstone. Casing will proceed as follows. A 10-1/2-inch hole opener will drill through the alluvium and any surface water. A 10-inch casing will be set and grouted, then a smaller hole (about 7-1/2-inch) will be drilled to the Castlegate and 6-5/8 to 7-inch diameter casing will be set for the entire length of the hole. The remainder of the hole will be drilled as follows:

1) Change to 5-5/8" tricone rock bit.
2) Drill to core point with air-mist injection.
3) Core 30' of roof, coal seam, and 5' of floor with 4-1/2" x 3" core barrel.
4) Ream cored interval with 5-5/8" tricone rock bit.
5) Drill about 100' to total depth.

Drilling will be done with air until wet sand is encountered, then air-mist injection will be used. If necessary, water will be hauled from an approved source by truck.

Use of air-mist injection will minimize water usage and will also minimize water truck travel on location roads.

Drill water economy cannot be estimated at this time. Drilling mud will be used only in the event of circulation problems.

Archeological Survey

An archeological survey will be performed by a professional archeological consultant on drill sites and access routes prior to drilling permit being issued.

Protection of the Environment

The preservation of the environment will be of concern through all phases of this drilling program. All drill sites are planned to minimize disturbance to the terrain. Pits will be used to contain all water and mud used in drilling. These drilling fluids will not be allowed to run into the stream drainages.

All ground water aquifers will be protected by cementing the drill hole in compliance with the "Rocking Mountain Area Well Abandonment Requirements," unless it is deemed necessary to convert all or some of the holes to water monitoring stations. In the event that water monitoring stations are necessary, an addendum to this application will be submitted detailing hole completion procedures.

Throughout all phases of this drilling program, the personnel of the district ranger's office of the U. S. Forest Service will be informed of all drilling and reclamation progress.

It has been Coastal's policy to reclaim all drill sites and associated roads to the same condition, or in some cases, better condition than they were prior to drilling. During this drilling program, Coastal shall continue to use its best efforts to protect all aspects of the environment in the region.

Air Pollution - No burning will be allowed.
Wildlife - Drilling operations will not occur during elk calving season.
Public Health & Safety - Drilling operations will be conducted in a safe and efficient manner, minimizing the contact with the public and environment.
Laws and Regulations - Responsibility lies within Coastal States Energy Company to comply with all regulations of the BLM, USGS, Forest Service and State of Utah and to assure that contractors and sub-contractors know and understand the exploration plan and its stipulations. Sundry notices will be submitted to the USGS in a timely manner after exploration is completed.

Surface Reclamation

Reclamation will be performed contemporaneously with drilling. Upon completion of drilling and testing, the holes will be cemented to the top. The site will be cleaned and all material foreign to the natural setting will be buried or removed. Liquids in the pits will be allowed to evaporate or will be spread on approved roads. The pit will be filled with the stockpiled soil. The area will be raked with a power rake and the seed mixture will be sown with a hand spreader. Seed will be buried by a drag attached to a pickup. Since drilling will take place during the dry summer months, seeding will be postponed until the fall season. No fertilizer will be applied to avoid attracting animals to a greener patch.

Seed Mixture and Density

Crested Wheatgrass - Fairway Strain	- 4# per acre
Sodar Streambank Wheatgrass	- 4# per acre
Hard Fescue (Durar)	- 4# per acre
Ladak Alfalfa (innoculated)	- 2# per acre
	14# per acre

ESTIMATED TIME TABLE

The archeological survey will be conducted in late May or early June, 1981.

The drilling program would begin on June 15, 1981 (or earlier with Forest Service approval) and be completed by August 1, 1981. We have estimated that no more than 15 days will be required for any one drill site. A list of hole locations and depths is given in Table I.

Table I

Hole #	Location	Elevation	Total Depth
	(T.21S.,R.5E.,SLM)		
US-81-1	Sec. 30: NW-1/4, SE-1/4, SW-1/4 (T.21S.,R.4E.,SLM)	8500'	1250'
US-81-2	Sec. 25: SE-1/4, SW-1/4, SE-1/4	8680'	1400'
US-81-3	Sec. 25: SW-1/4, SW-1/4, SW-1/4	9140'	1930'
US-81-4	Sec. 25: NW-1/4, NW-1/4, NW-1/4	8440'	1350'

REFERENCES

Doelling, H. H., 1972, Central Utah Coal Fields: Sevier - Sanpete, Wasatch Plateau, Bookcliffs and Emery, Utah Geological and Mineralogical Survey Monograph Series, No. 3.

Smith, H. Duane, 1980, Wildlife Assessment of the Southern Utah Fuel Company Mining Property and Adjacent Areas, Sevier County, Utah, in Amendment to the Mining and Reclamation Plan for the Southern Utah Fuel Company Mine and revised Mining Permit Application.

White, Clayton M., 1980, Raptor and General Avifauna Studies, SUFCo Mine, Convulsion Canyon, July - August, 1980, Department of Zoology, Brigham Young University, Provo, Utah, in Amendment to the Mining and Reclamation Plan for the Southern Utah Fuel Company Mine and revised Mining Permit Application.

SUMMARY REPORT
SLOPE STABILITY ANALYSIS
SEDIMENTATION POND ACCESS ROAD
SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON MINE
LOCATED EAST OF SALINA, UTAH
FOR COASTAL STATES ENERGY COMPANY

Feb. 16, 1981

SUMMARY REPORT
SLOPE STABILITY ANALYSIS
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SOUTHERN UTAH FUEL COMPANY
CONVULSION CANYON MINE
LOCATED EAST OF SALINA, UTAH
FOR COASTAL STATES ENERGY COMPANY

ACT/041/002

DAMES & MOORE JOB NO. 6701-016-06
SALT LAKE CITY, UTAH
FEBRUARY 16, 1981

Dames & Moore

250 East Broadway, Suite 200
Salt Lake City, Utah 84111
(801) 521-9255
TWX: 910-925-5692 Cable address: DAMEMORE

February 16, 1981

Coastal States Energy Company
411 West 7200 South
Suite 200
Midvale, Utah 84047

Attention: Mr. Allon Owen

Gentlemen:

Summary Report
Slope Stability Analysis
Sedimentation Pond Access Road
Southern Utah Fuel Company
Convulsion Canyon Mine
Located East of Salina, Utah
For Coastal States Energy Company

INTRODUCTION

This report summarizes the results of our stability analysis of the slopes along the sedimentation pond access road at Southern Utah Fuel Company, Convulsion Canyon Mine located east of Salina, Utah.

PURPOSE AND SCOPE

The purpose and scope of this study were planned in discussions between Mr. Allon Owen of Coastal States Energy Company and Mr. Bill Gordon of Dames & Moore. In general, the purpose of this investigation was to analyze the static factor of safety of the sideslopes along the sedimentation pond access road.

BACKGROUND

In order to obtain access to the site of a proposed sedimentation pond, it was necessary to construct an access road along the southeast-facing slope, near the mine mouth facilities at the Convulsion Canyon Mine. Now that the sedimentation pond has been completed, the road will only be used during periods of sediment removal. It is projected that this will occur once every two or three years.

In December, 1980, Coastal States Energy Company was issued a citation at Southern Utah Fuel Company Convulsion Canyon Mine (violation No. N 80-1-13-2, No's 1 & 2). The nature of the violation No. 1, as issued by the Department of Natural Resources Division of Oil, Gas, and Mining was stated as "failure to retain all earth, rock and other mineral non-waste materials on the solid portion of the existing or new benches of road cuts, mine workings or other benches."

SITE CONDITIONS

SURFACE

The sedimentation pond access road is located immediately south of the mine mouth facilities at the Convulsion Canyon Mine. The access road extends from the main entrance road, downward in a northeasterly direction to the sedimentation pond. The 22 foot wide dirt road cuts across a southeasterly-facing hillside. The hillside has a slope on the order of 33 to 38 degrees. In constructing the road, cuts and fills of 14 and 10 feet were constructed. Numerous large boulders and rock outcrops are present along the hillside. Ground surface vegetation consists of a very sparse cover of short weeds and scattered pinion pine trees.

SUBSURFACE

EXPLORATION

Subsurface soil and ground water conditions along the access road were explored by excavating two test pits to depths of 9.5 and 10.5 feet below existing ground surface. The test pits, excavated using a rubber tire-mounted backhoe, were located along the downslope side of the access road. Samples were also obtained from the cut area along the upslope portion of the road between the two test pits. Tabulated logs of the subsurface soil conditions encountered in the two test pits are presented below:

Test Pit 1

(located along downslope edge of access road, approximately 250 feet from the juncture of the access road and the main entrance road)

0.0' to 7.5'	Gray brown fine to coarse sandy clayey silt with some fine and coarse gravel and occasional cobbles and pieces of rubble (fill) - loose - ML/CL
7.5' to 9.5'	Gray silty clay, stiff to very stiff - CL/ML

Ground water was not encountered to the depth penetrated.

Test Pit 2

(located on the downslope of the access road, approximately 350 feet from the juncture of the access road and the main entrance road)

0.0' to 10.5'	Gray brown fine and coarse sandy clayey silt with some fine and coarse gravel and occasional cobbles and pieces of rubble (fill) loose -ML/CL

Ground water was not encountered to the depth penetrated.

The fill material, extending to a depth of 9.5 feet in Test Pit 1, and to the depth penetrated in Test Pit 2, 10.5 feet, typically consists of gray brown, fine to coarse sandy clayey silt with varying amounts of fine and coarse gravel and occasional cobbles. Occasional pieces of miscellaneous rubble and debris were also encountered in the fill material at both test pit locations. Underlying the fill material in Test Pit 2, natural gray silty clay was encountered and extended to the depth penetrated, 9.5 feet below surrounding grade. The consistency of the natural silty clay was typically stiff to very stiff.

The depths designating the interface between soil types on the test pit logs generally represent the approximate boundaries. In-situ, the transition between materials may be gradual.

No ground water was encountered during excavation and sampling of the test pits.

LABORATORY TESTING

GENERAL

A laboratory testing program was conducted to provide data for engineering analyses. The program included sieve, collapse, compaction, and direct shear tests. The following paragraphs describe the tests and summarize the test results.

SIEVE ANALYSES

To aid in classifying the soils and help correlate other test data, sieve analyses were performed on selected disturbed samples

of the existing fill material. The results of the sieve analyses are tabulated below:

Sample No.	Percent Passing Sieve #4	#10	#40	#200
1	81.1	75.3	65.4	51.0
2	76.2	71.6	67.1	51.3

COLLAPSE TESTS

Collapse tests were performed on representative samples of the brown fine to coarse sandy clayey silt fill material encountered at the site, in order to assess moisture sensitivity characteristics of the end-dumped fill material. The data obtained from these tests were used in evaluating the overall stability of the side-slopes. Results of the collapse tests are tabulated below:

Test Pit Number	Depth (feet)	Soil Type	Natural Dry Density (pcf)	Natural Moisture Content (percent)	Axial Load When Saturated (psf)	Collapse (-) or Swell (+) (percent)
1	1.0	ML/CL	94.9	9.5	800	2.0 (-)
*	4.0	ML/CL	96.9	11.8	800	4.0 (-)

*Sample obtained in fill soils exposed along upslope road cut between Test Pits 1 and 2.

COMPACTION TESTS

A compaction (modified proctor) test was performed in accordance with the AASHTO*T-180 (ASTM**D-1557) specifications

*American Association of State Highway and Transportation Officials
**American Society for Testing and Materials

LIST OF USE

DAMES AND MOORE PROGRAM EPI - (SLOPES)

SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

DATE OF LAST REVISION - DEC 11 78

DATE RUN - 01/30/81 TIME RUN - 17.33.14

0670101606 0107 GMB 013001 SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPINGS

DATA INPUT MODE = 1
EARTHQUAKE COEFFICIENT = 0.000
PORE PRESSURE IS DEFINED BY WATER LINE DATA
TOTAL NUMBER OF SOIL LINES = 3 NUMBER OF WATER LINES = 0
0SLOPE GEOMETRY DATA

LINE NO	LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1090.00	1060.00	1102.00	1060.00	107.0	0.00	25.00	0.0	500.0	0.000	0.000	0	0	0
2	1102.00	1060.00	1180.00	1002.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
3	1000.00	1100.00	1182.00	996.00	135.0	29.00	0.00	500.0	20000.0	0.000	0.000	0	0	0

NOTE: IF(NEW.EQ.1) SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH N.U=1
IF(NUU.EQ.1) SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH N.U=1

UNIT WEIGHT OF WATER = 62.40 NUMBER OF COLUMN LOADS = 0

MODE OF PROGRAM OPERATION = 1

RESULTS

ENTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMS	SUM	SUM2	XR	XL	ARC	AN	TRIAL
1	1	1200.00	1140.00	130.00	2.379	(2.049)	24707.	24	3307.	1161.33	1097.53	78.76	1	2

RDY
BYE
CT = 00.71 SU-A = 8.3
MCH = 25
0634016 LOG OFF. 17.33.13.

BANES AND MOORE PROGRAM EP1 (CLOSED)

SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

[illegible]

0670101606 0:07 E:8 013021 SLOPE STABILITY ... BLOCK OUTCROPPING

[illegible]

DATA INPUT MODE = 1
EARTHQUAKE COEFFICIENT = 0.000
PORE PRESSURE IS DEFINED BY WATER LINE DATA
TOTAL NUMBER OF SOIL LINES = 5 NUMBER OF WATER LINES = 0
0SLOPE GEOMETRY DATA

LINE NO	COORDINATES - LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA ID BELOW LINE-PCF	FRICT.ANGLE(DEG) OR C/P-RATIO** ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUT BELOW
1	1000.00	1110.00	1022.00	1110.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
2	1022.00	1110.00	1066.00	1076.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
3	1066.00	1078.00	1078.00	1074.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
4	1078.00	1074.00	1080.00	1060.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
5	1080.00	1060.00	1090.00	1020.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0

NOTE: IF(NEW.EQ.1) SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
IF(NUU.EQ.1) SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

UNIT WEIGHT OF WATER = 62.40 NUMBER OF COLUMN LINES = 0

MODE OF PROGRAM OPERATION = 1
1

RESULTS

CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELLENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1118.00	1128.00	74.00	2.893	(2.344)	5963.	5962.	820.	1079.30	1059.42	26.87	1	2
2	1	1122.00	1172.00	116.00	2.235	(1.899)	23506.	23385.	3668.	1079.41	1025.73	69.96	1	2

RDY

BY D. Burk DATE 1-30-81

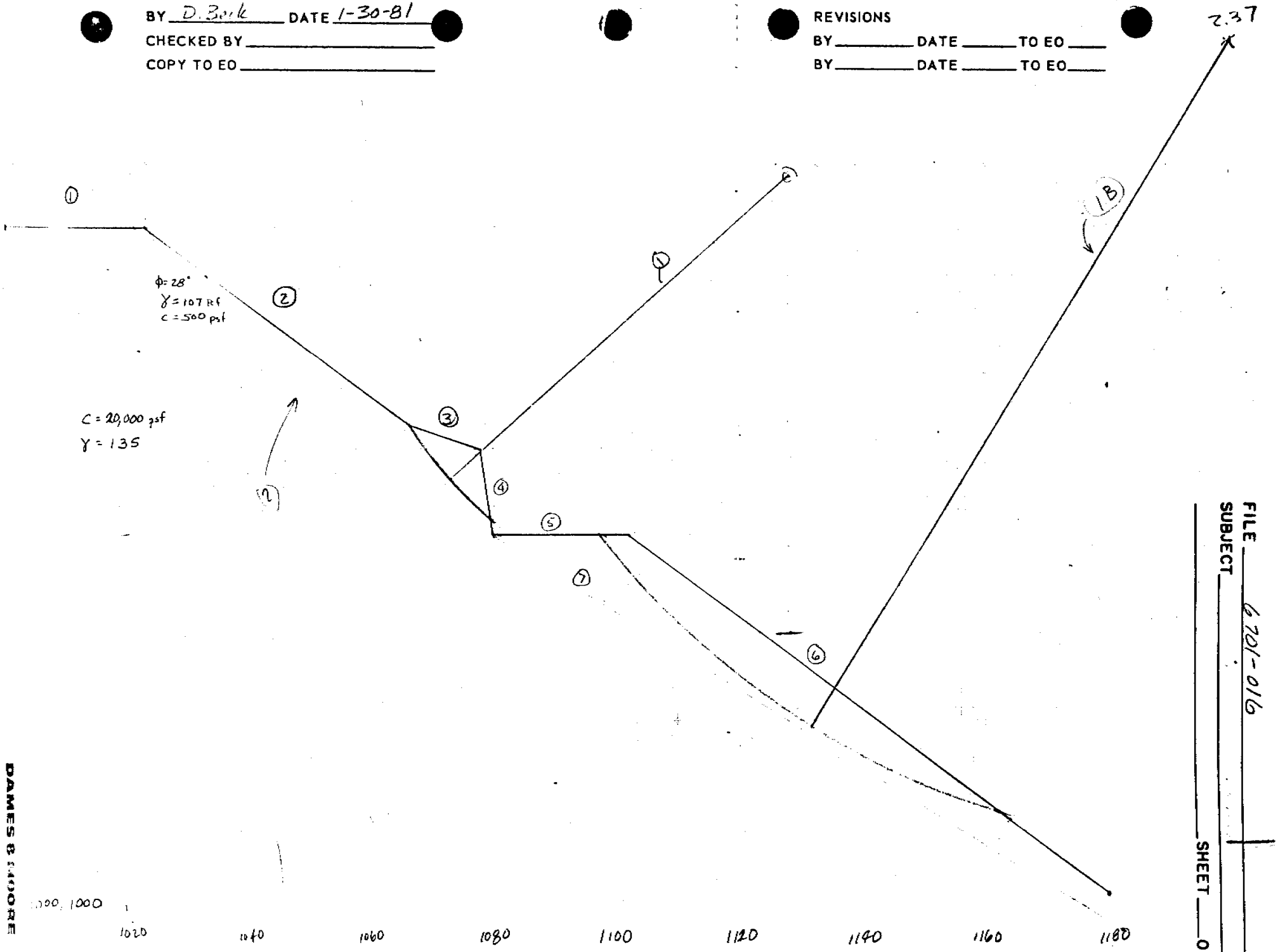
CHECKED BY

COPY TO EO

REVISIONS

BY DATE TO EO

BY DATE TO EO



FILE 6701-016

SUBJECT

SHEET OF

DAMES & MOORE

in order to determine the maximum dry density of the existing fill materials. Results of the test are presented below:

Soil Description	Soil Type	Maximum Dry Density (pcf)	Optimum Moisture Content (percent)
Gray brown fine to coarse sandy clayey silt*	ML/CL	127.5	8.7

*Bulk sample of existing fill material provided by Coastal States Energy Company

DIRECT SHEAR TESTS

Direct shear tests were performed on four remolded samples of the gray brown fine to coarse sandy clayey silt fill material at the site. These remolded samples were compacted to densities varying from 83.0 to 85.2 percent of the maximum dry density as determined by the compaction (modified proctor) test previously performed. The data obtained from these tests were used in evaluating the long-term stability of the embankment slopes. Results of the direct shear tests are tabulated below:

Sample Number	Dry Density (pcf)	Moisture Content (percent)	Compaction* (percent)	Normal Pressure (psf)	Peak Shear Strength (psf)
1	108.6	7.2	85.2	1000	1880
2	105.9	7.0	83.0	2000	2310
3	106.0	7.3	83.1	3000	3300
4	106.5	6.8	83.5	4000	3910

*AASHTO T-180 (ASTM D-1557) method of compaction.

A plot of the above data indicates an angle of internal friction ϕ of 36° and a cohesion of 1000 pounds per square foot.

SLOPE STABILITY ANALYSIS

To aid in evaluating the stability of both the upslope and downslope embankments of the sedimentation pond access road, a computer slope stability analysis was performed. The computer analysis utilized a simplified Bishop's Method in computing the long-term static factor of safety of the slopes. Due to the uncontrolled method in which the fill materials were placed, soil strength parameters obtained from the direct shear tests were significantly decreased for use in the computer analysis. Due to the numerous large boulders and rock outcrops observed at the site, a shallow bedrock surface was assumed in the analysis. A geometric cross section utilized in the analysis is shown on Plate 1, Slope Cross Section. It was also assumed that a phreatic water surface would not develop in the slopes of the embankments.

Two different sets of soil parameters were utilized in performing the computer analysis. Three trial arcs were analyzed using the soil parameters listed below:

Angle of internal friction	$\phi = 28^{\circ}$
Cohesion	C = 500 psf
Unit weight soil	γ = 107 pcf

The results of this analysis indicated a factor of safety varying from 2.2 to 2.9 for the trial arcs analyzed.

A second series consisting of 10 trial arcs were analyzed utilizing the soil parameters listed below:

Angle of internal friction	$\phi = 26^{\circ}$
Cohesion	C = 350 psf
Unit weight soil	γ = 107 pcf

This second series included the three trial arcs analyzed in the first series plus seven additional trial arcs not previously analyzed. This analysis indicated a factor of safety varying from 1.7 to 3.3 for the trial arcs analyzed.

Copies of the results of the computer analysis for each trial arc are included with this report.

DISCUSSIONS AND RECOMMENDATIONS

GENERAL

Supporting data upon which our recommendations are based have been presented in the previous sections of this report.

SLOPE STABILITY

The computer slope stability analysis indicates an overall long-term static factor of safety varying from 1.7 to 3.3 for the trial arcs analyzed.

Although the slope stability analysis indicates a factor of safety in excess of 1.5, consideration should be given to the site conditions and the uncontrolled methods under which the fill material was placed. Stability of the slopes will be influenced by the degree of saturation of the existing soils. Therefore, surface drainage should be channeled to minimize runoff over the slopes. We have discussed these drainage considerations with representatives of Coastal States Energy Company and they will utilize ditches, berms and water bars to minimize erosion and excessive wet conditions on the cuts and side cast slopes.

During wet periods of the year, small localized slides and sloughs should be anticipated along the full slopes. However, the problems created by these occurrences should be minor. Immediately prior to removal of the accumulated material in the sedimentation pond, minor regrading and clearing of the roadway will probably be necessary to remove soil material deposited on the roadway as a result of minor sloughs and slides.

oOo

We appreciate the opportunity of performing this service for you. If you have any questions or require additional information, please contact us.

Very truly yours,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

Douglas G. Beck

Douglas G. Beck
Staff Engineer

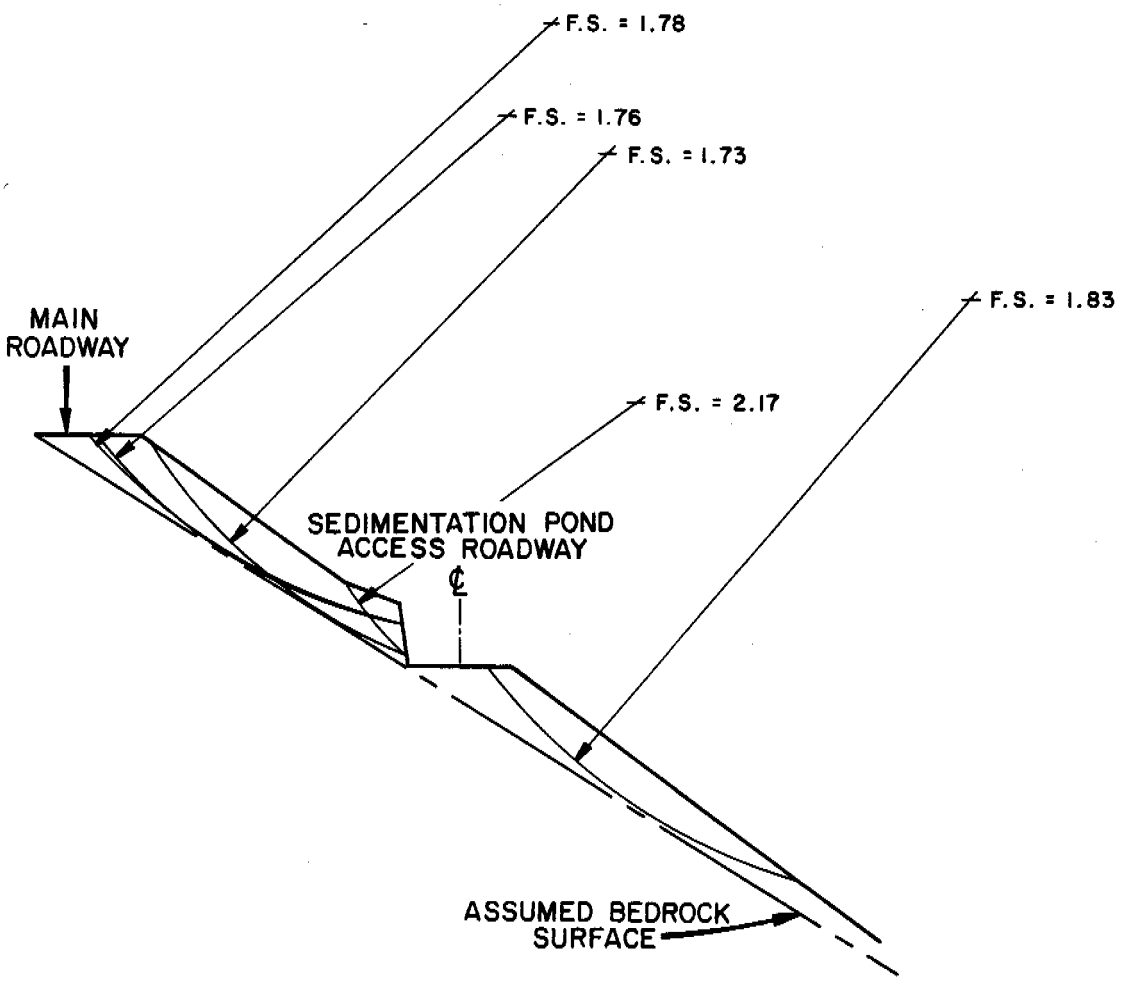
WJG/DGB/wb

Attachments:
Plate 1 - Slope Cross Section
Computer Analysis Results

REVISIONS
BY _____ DATE _____

BY _____ DATE _____
CHECKED BY _____

FILE _____



SLOPE CROSS-SECTION

FEET
20 0 40 60

DAMES & MOORE

PLATE 1

01/30/81. 17.25.31.
LIST OF GMB

1**********

DAMES AND MOORE PROGRAM EP1 (SLOPEB)

SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

DATE OF LAST REVISION - DEC 11 78

DATE RUN - 01/30/81 TIME RUN - 17.24.36

0670101606 0107 GMB 013081 SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

****

DATA INPUT MODE = 1
EARTHQUAKE COEFFICIENT = 0.000
PORE PRESSURE IS DEFINED BY WATER LINE DATA
TOTAL NUMBER OF SOIL LINES = 5 NUMBER OF WATER LINES = 0
0SLOPE GEOMETRY DATA

LINE NO	COORDINATES LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1000.00	1110.00	1022.00	1110.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
2	1022.00	1110.00	1066.00	1078.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
3	1066.00	1078.00	1078.00	1074.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
4	1078.00	1074.00	1080.00	1060.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0
5	1080.00	1060.00	1090.00	1020.00	107.0	0.00	28.00	0.0	500.0	0.000	0.000	0	0	0

NOTE: IF(NEW.EQ.1) SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
IF(NUU.EQ.1) SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

UNIT WEIGHT OF WATER = 62.40 NUMBER OF COLUMN LOADS = 0

MODE OF PROGRAM OPERATION = 1
1

RESULTS

CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1110.00	1128.00	74.00	2.893	(2.344)	5963.	5962.	820.	1079.30	1059.42	26.87	1	2
2	1	1122.00	1172.00	116.00	2.235	(1.899)	23586.	23585.	3668.	1079.41	1025.73	69.96	1	2

RDY

```
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST
```

Trial #2

```
 02/03/81. 16.43.31.
 LIST OF  GMB

1*******************************************************************************

 DAMES AND MOORE PROGRAM EP1     (SLOPEB)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81   TIME RUN -  16.43.14

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *******************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   5     NUMBER OF WATER LINES =  0
0SLOPE GEOMETRY DATA
```

LINE NO	COORDINATES - LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1000.00	1110.00	1022.00	1110.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
2	1022.00	1110.00	1066.00	1078.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
3	1066.00	1078.00	1078.00	1074.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
4	1078.00	1074.00	1080.00	1060.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
5	1080.00	1060.00	1090.00	1020.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0

```
  NOTE:  IF(NEW.EQ.1)  SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
         IF(NUU.EQ.1)  SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
         VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

 UNIT WEIGHT OF WATER =   62.40      NUMBER OF COLUMN LOADS =   0

 MODE OF PROGRAM OPERATION =   1
1                                  RESULTS
                                   -------
```

CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1080.00	1180.00	100.00	2.021	(1.849)	18835.	18835.	2217.	1060.65	1008.59	60.07	1	3
2	1	1100.00	1180.00	110.00	2.009	(1.784)	21822.	21813.	2879.	1078.26	1015.15	75.03	1	2
2	2	1100.00	1180.00	112.00	1.764	(1.582)	29611.	29611.	4320.	1078.56	1012.57	78.74	1	3
3	1	1100.00	1160.00	90.00	3.326	(2.841)	8238.	8237.	745.	1078.19	1028.62	60.41	1	2
3	2	1100.00	1160.00	92.00	2.303	(1.979)	15633.	15631.	2019.	1078.49	1023.48	68.66	1	2
3	3	1100.00	1160.00	94.00	1.844	(1.598)	23967.	23962.	3759.	1078.80	1020.40	73.55	1	2
4	1	1110.00	1200.00	134.00	1.775	(1.608)	29873.	29873.	4255.	1078.61	1010.72	80.12	1	3

```
*RDY*

BYE
CT = 00.13    SU-A =       1.7
KCH =    5
D034016   LOG OFF.   16.46.05.
```

```
1. 17.33.33.
  GMB

**********************************************************************

ND MOORE PROGRAM EP1    (SLOPEB)

TABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 LAST REVISION - DEC 11 78

 -  01/30/81   TIME RUN -  17.33.14

506 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

(**********************************************************************

'UT MODE = 1
IKE COEFFICIENT =  0.000
:SSURE IS DEFINED BY WATER LINE DATA
JMBER OF SOIL LINES =   3     NUMBER OF WATER LINES =   0
:OMETRY DATA                          SOIL DATA, FRICT.ANGLE(DEG)                                  PORE
 - - - - COORDINATES - - - - -  WT BELOW   (OR C/P-RATIO**)    COHESION-PSF   PRESSURE RATIO      NEW   NUU   NUU
.EFT-X    LEFT-Y   RIGHT-X   RIGHT-Y  LINE-PCF   ABOVE    BELOW    ABOVE    BELOW   ABOVE BELOW   BELOW ABOVE BELOW
)80.00   1060.00  1102.00  1060.00     107.0   0.00    28.00      0.0    500.0   0.000 0.000       0     0     0
.02.00   1060.00  1180.00  1002.00     107.0   0.00    28.00      0.0    500.0   0.000 0.000       0     0     0
)00.00   1100.00  1182.00   996.00     135.0  28.00     0.00    500.0  20000.0   0.000 0.000       0     0     0

IF(NEW.EQ.1)  SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
IF(NUU.EQ.1)  SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

GHT OF WATER =   62.40      NUMBER OF COLUMN LOADS =   0

PROGRAM OPERATION =   1

                                RESULTS
                                -------

=============================================================================================================
D   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY    SUMWS     SUM1      SUM2       XR        XL       ARC    NN  TRIAL
O      X         Y      RADIUS   BISHOP  FELENIUS
    1200.00   1140.00   130.00   2.374   ( 2.049)   24739.    24736.     3387.   1161.33   1097.53   78.76   1    2


1    SU-A =       8.3
5
 LOG OFF.   17.35.13.
```

```
 01/30/81. 17.33.33.
 LIST OF  GMB

1*********************************************************************************

 DAMES AND MOORE PROGRAM EP1    (SLOPEB)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  01/30/81   TIME RUN -  17.33.14

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *********************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   3     NUMBER OF WATER LINES =   0
0SLOPE GEOMETRY DATA                          SOIL DATA, FRICT.ANGLE(DEG)                                  PORE
 LINE   - - -  - COORDINATES -  - - - -   WT BELOW   (OR C/P-RATIO**)    COHESION-PSF   PRESSURE RATIO      NEW   NUU   NUU
  NO    LEFT-X    LEFT-Y   RIGHT-X   RIGHT-Y   LINE-PCF   ABOVE   BELOW   ABOVE   BELOW   ABOVE  BELOW   BELOW ABOVE BELOW
   1   1080.00   1060.00   1102.00   1060.00     107.0    0.00   28.00     0.0   500.0   0.000  0.000       0     0     0
   2   1102.00   1060.00   1180.00   1002.00     107.0    0.00   28.00     0.0   500.0   0.000  0.000       0     0     0
   3   1000.00   1100.00   1182.00    996.00     135.0   28.00    0.00   500.0 20000.0   0.000  0.000       0     0     0

  NOTE:  IF(NEW.EQ.1)  SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
         IF(NUU.EQ.1)  SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
         VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

 UNIT WEIGHT OF WATER =   62.40      NUMBER OF COLUMN LOADS =   0

 MODE OF PROGRAM OPERATION =   1
1                                    RESULTS
                                     -------

 ==========================================================================================================================
 CNTR  RAD   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY    SUMWS     SUM1      SUM2       XR        XL        ARC    NN  TRIAL
  NO    NO      X         Y     RADIUS   BISHOP  FELENIUS
   1    1   1200.00   1140.00   130.00   2.374   (  2.049)   24739.   24736.    3387.   1161.33   1097.53   78.76   1    2
*RDY*
BYE
CT = 00.71    SU-A =       8.3
KCH =   25
D034Q16   LOG OFF.   17.35.13.
```

```
00290 107./0./26./0./350.
00300 107./0./26./0./350.
00310 135./26./0./350./20000.
REP
*RDY*

RJE
 EQPSD8Q / RJE       ROUTED TO APEX

*RDY*
RJS,EQPSD8Q
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST

 02/03/81. 16.19.05.
 LIST OF  GMB

1*******************************************************************************

 DAMES AND MOORE PROGRAM EP1    (SLOPE8)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81   TIME RUN -  16.18.46

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *******************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   3     NUMBER OF WATER LINES =   0
OSLOPE GEOMETRY DATA
```

LINE NO	COORDINATES LEFT-X	LEFT-Y	RIGHT-X	RIGHT-Y	SOIL DATA, WT BELOW LINE-PCF	FRICT.ANGLE(DEG) (OR C/P-RATIO**) ABOVE	BELOW	COHESION-PSF ABOVE	BELOW	PORE PRESSURE RATIO ABOVE	BELOW	NEW BELOW	NUU ABOVE	NUU BELOW
1	1080.00	1060.00	1102.00	1060.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
2	1102.00	1060.00	1180.00	1002.00	107.0	0.00	26.00	0.0	350.0	0.000	0.000	0	0	0
3	1000.00	1100.00	1182.00	996.00	135.0	26.00	0.00	350.0	20000.0	0.000	0.000	0	0	0

```
  NOTE:  IF(NEW.EQ.1)  SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
         IF(NUU.EQ.1)  SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
         VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

 UNIT WEIGHT OF WATER =   62.40      NUMBER OF COLUMN LOADS =   0

 MODE OF PROGRAM OPERATION =   1
1                                    RESULTS
                                     -------
```

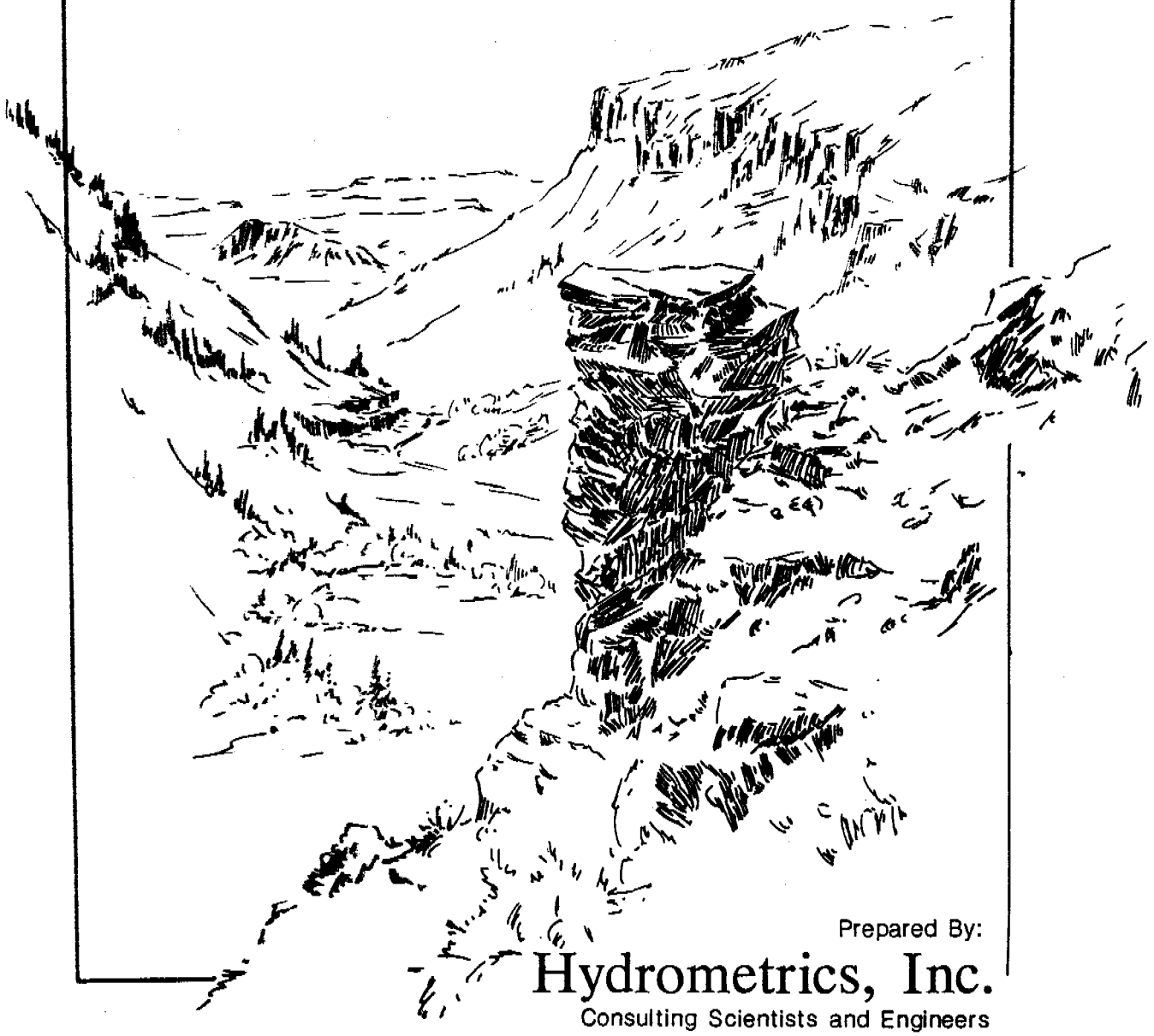
CNTR NO	RAD NO	CENTER COORDINATES X	Y	CIRCLE RADIUS	FACTOR OF SAFETY BISHOP	FELENIUS	SUMWS	SUM1	SUM2	XR	XL	ARC	NN	TRIAL
1	1	1200.00	1140.00	130.00	1.832	(1.599)	24739.	24733.	3916.	1161.33	1097.53	78.76	1	2

```
*RDY*


BYE
CT=  20.36    SU=  3.9
```

```
RJS,EQPSD6M
     APEX INPUT QUEUE.
RJS._,EQPSD6M
NOT FOUND.
OLD,GMB
*RDY-FOR*
LIST

 02/03/81. 16.13.20.
 LIST OF  GMB

1*******************************************************************************

 DAMES AND MOORE PROGRAM EP1    (SLOPE8)

 SLOPE STABILITY ANALYSIS - SIMPLIFIED BISHOP'S METHOD

 DATE OF LAST REVISION - DEC 11 78

 DATE RUN -  02/03/81   TIME RUN -  16.12.38

 0670101606 0107 GMB 013081  SLOPE STABILITY CUTSLOPE W ROCK OUTCROPPING

 *******************************************************************************

 DATA INPUT MODE = 1
 EARTHQUAKE COEFFICIENT =  0.000
 PORE PRESSURE IS DEFINED BY WATER LINE DATA
 TOTAL NUMBER OF SOIL LINES =   5     NUMBER OF WATER LINES =   0
0SLOPE GEOMETRY DATA
 LINE   - - - - COORDINATES - - - - -  SOIL DATA, FRICT.ANGLE(DEG)                          PORE
  NO    LEFT-X    LEFT-Y   RIGHT-X   RIGHT-Y  WT BELOW  (OR C/P-RATIO**)   COHESION-PSF  PRESSURE RATIO    NEW   NUU   NUU
                                               LINE-PCF   ABOVE   BELOW   ABOVE   BELOW   ABOVE  BELOW   BELOW ABOVE BELOW
   1   1000.00  1110.00  1022.00  1110.00      107.0    0.00    26.00     0.0   350.0   0.000  0.000      0     0     0
   2   1022.00  1110.00  1066.00  1078.00      107.0    0.00    26.00     0.0   350.0   0.000  0.000      0     0     0
   3   1066.00  1078.00  1078.00  1074.00      107.0    0.00    26.00     0.0   350.0   0.000  0.000      0     0     0
   4   1078.00  1074.00  1080.00  1060.00      107.0    0.00    26.00     0.0   350.0   0.000  0.000      0     0     0
   5   1080.00  1060.00  1090.00  1020.00      107.0    0.00    26.00     0.0   350.0   0.000  0.000      0     0     0

  NOTE:  IF(NEW.EQ.1)  SOIL IS NEWLY PLACED AND DOES NOT CONSOLIDATE LAYERS WITH NUU=1
         IF(NUU.EQ.1)  SOIL WILL BE LOADED UNDER UNDRAINED CONDITIONS BY NEWLY PLACED LAYERS
         VALUES MARKED WITH ** ARE C/P RATIOS FOR LAYERS WITH NUU=1

 UNIT WEIGHT OF WATER =   62.40      NUMBER OF COLUMN LOADS =   0

 MODE OF PROGRAM OPERATION =   1
1                                        RESULTS
                                         -------


 ==========================================================================================================================
 CNTR  RAD   CENTER COORDINATES   CIRCLE   FACTOR OF SAFETY    SUMWS     SUM1      SUM2       XR        XL        ARC   NN  TRIAL
  NO   NO      X         Y       RADIUS   BISHOP  FELENIUS
   1    1  1118.00   1128.00     74.00   2.169   (  1.788)    5963.     5963.     966.   1079.30   1059.42   26.87   1    2
   2    1  1122.00   1172.00    116.00   1.732   (  1.494)   23586.    23582.    4176.   1079.41   1025.73   69.96   1    2
*RDY*
```

Hydrological Assessment 1977 - 1987

Southern Utah Fuel Company
Mine No. 1 Salina, Utah



Prepared By:
Hydrometrics, Inc.
Consulting Scientists and Engineers

Hydrometrics, Inc.
2727 Airport Road • Helena, Montana 59601 • (406) 443-4150

September 14, 1987

Keith Welch
Coastal States Energy Company
175 East 400 South, Suite 800
Salt Lake City, UT 84111 - 2301

Dear Keith,

In reference to SUFCo Service Authorization No. 6573 and our recent telephone conversation, enclosed are four copies of the summary of surface and groundwater hydrology at the SUFCo No. 1 Mine near Salina, Utah. The summary includes a characterization of water quality, information on hydrologic balance, Hydrometrics' opinion on the impacts of mining on groundwater hydrology and geological discussion as it relates to mine area hydrology.

Please let me know if you have any questions or need additional information.

Sincerely,

Robert D. Braico, P. E.
Civil/Environmental Engineer

RDB:jy

Enclosures

c: Kerry Frame

HYDROLOGICAL ASSESSMENT 1977 - 1987
SOUTHERN UTAH FUEL COMPANY MINE NO. 1
SALINA, UTAH

for

Mr. Kerry Frame
Southern Utah Fuel Company
Highway 89 South
Salina, UT 84654

and

Mr. Keith Welch
Coastal States Energy Company
175 East 400 South, Suite 800
Salt Lake City, UT 84111-2301

by

HYDROMETRICS
2727 Airport Road
Helena, MT 59601
406/443-4150

September 14, 1987

TABLE OF CONTENTS

FIGURE LIST

TABLE LIST

APPENDIX

REPRESENTATIVE WATER QUALITY

PLATES

HYDROLOGICAL ASSESSMENT 1977 - 1987
SOUTHERN UTAH FUEL COMPANY MINE NO. 1
SALINA, UTAH

INTRODUCTION

This report summarizes ten years of baseline data and the effects of subsidence associated with SUFCo No. 1 Mine operations on area hydrology.

Southern Utah Fuel Company (SUFCo), a subsidiary of Coastal States Energy Company, operates an underground coal mine in the southern Wasatch Plateau near Salina, Utah. The company uses both the room and pillar recovery method (using continuous mining) and the longwall method. These techniques are full recovery methods that increase the percentage of coal resource recovery and results in subsidence of overlying materials. Overburden thickness above the coal varies with the plateau and canyon type topography, but averages about ~~700~~ 900 feet. The first subsidence at the SUFCo No. 1 Mine occurred in May 1977 as a result of underground mining. Additional areas were subsided in subsequent years. Subsidence at the surface is characterized by fracture systems (roughly parallel to the mined area) and as much as an eight-foot vertical drop in the ground surface.

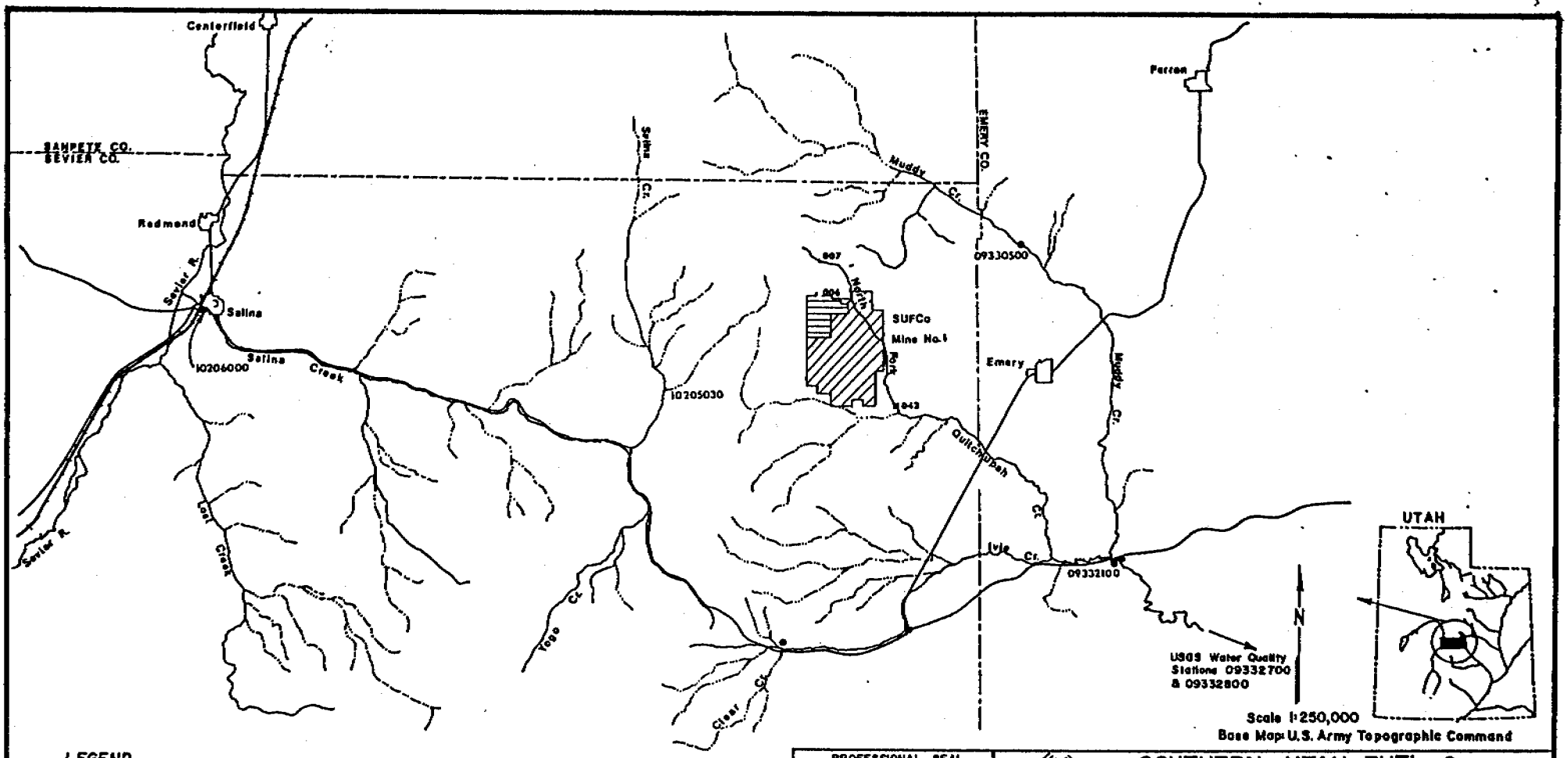
The SUFCo mine operates on a federal lease area. The U.S. Department of Agriculture, Fishlake National Forest, administers the surface property under lease. The coal leases are administered by the BLM. The U.S. Geological Survey was responsible for federal administrative

supervision of the mining activity when environmental impact studies began in 1977. However, primary federal responsibility is considered to have passed to the U.S. Department of the Interior, Office of Surface Mining, in March 1979 with the passage of the Federal Surface Mining Control and Reclamation Act (SMCRA). The Utah Division of Oil, Gas and Mining is responsible for administrative supervision on the state level and recently assumed primary responsibility for the OSM regulatory program.

Ground subsidence may alter groundwater and surface water systems in the vicinity of the mine. Therefore, in 1977, Coastal States Energy Company initiated investigation of water resources in the mine area which would permit evaluation of potential effects of subsidence on hydrology. This investigation was begun in September 1977. Additional data have been collected in each of the subsequent years.

REGIONAL HYDROLOGY AND GEOLOGY

The Wasatch Plateau, located in central Utah, is described as a high plateau feature and is part of the large physiographic province known as the Colorado Plateau. The SUFCo study area is located in the Salina Planning Unit of the Fishlake National Forest, in the southeastern part of the Wasatch Plateau. The SUFCo No. 1 Mine portal is about 16 miles east of Salina, Utah and is in a tributary drainage (East Spring Canyon) of Convulsion Canyon in Section 12 of Township 22 South, Range 4 East (Figure 1). Precipitation in the area varies from


Centerfield
SANPETE CO.
SEVIER CO.
Redmond
Sevier R.
Salina
10206000
Salina Creek
Lost Creek
Sevier R.
Salina Cr.
10205030
Muddy Cr.
EMERY CO.
09330500
North Fork
SUFCo Mine No.1
Emery
Muddy Cr.
Quitchupah Cr.
Ivie Cr.
09332100
Yago Cr.
Clear Cr.
Perron
UTAH
N
USGS Water Quality Stations 09332700 & 09332800
Scale 1:250,000
Base Map: U.S. Army Topographic Command
LEGEND
USGS Gaging Station
SUFCo Gaging Station
NOAA Met. Station
Mine Plan Area
USGS Water Quality Station
FISHLAKE NATIONAL FOREST
Boundary of Emergency Lease Area
Prepared By
HYDROMETRICS Helena, Mt. July 80 by: JS
PROFESSIONAL SEAL
SOUTHERN UTAH FUEL Co.
A SUBSIDIARY OF
COASTAL STATES ENERGY Co.
SURFACE WATER DRAINAGE SYSTEM
IN THE
SUFCo MINE No.1 AREA
NEAR SALINA, UTAH
JOB No.
DWG No.
REVISIONS
FIGURE 1

16 to 20 inches and 75 percent of the annual precipitation falls as snow.

Geologically, the Wasatch Plateau lies in a zone of transition between the San Rafael Swell to the east and the structurally complex Great Basin to the west. Geological formations of the Wasatch Plateau range in age from Upper Cretaceous to Tertiary with some unconsolidated Quaternary deposits. The dominant cliff and slope topography of the plateau region generally results from differential weathering of resistant units (sandstones and limestones) and non-resistant units (shales and coal).

Geological units at the SUFCo No. 1 Mine area range from the Masuk Shale Member of the Mancos Formation to the younger Price River Formation of Upper Cretaceous age. Rock exposures include shales of marine and continental origin, sandstones of several depositional origins and coals of transitional marine and continental origins. The most important geological units in the area are (beginning with the lowest unit) the Upper Mancos Shale Member (Masuk) which is about 600 feet thick in this part of the Wasatch Plateau and underlies the entire area. It is a yellow to blue-gray claystone and forms steep slopes at the base of the overlying Star Point Formation. This shale unit has little primary permeability for groundwater movement.

Overlying the Upper Mancos Shale Member is the Star Point Sandstone which is about 200 feet thick and is a fine to medium-grained

sandstone with grain size increasing upwards. The unit is light to medium gray and weathers to a light-brown appearance. Topographically, the Star Point forms a well defined cliff between the slopes of the Upper Mancos Shale and the overlying Blackhawk Formation. Permeability of the Star Point is a function of the degree of cementation between sand grains.

The Blackhawk Formation overlies the Star Point Sandstone and is composed of sandstones, siltstones, shales, coals and other carbonaceous material interbedded to varying degrees. Thickness of the formation is about 700 feet in the area of the mine and it weathers to a step-like slope. Coal beds of economic interest in the Blackhawk include the Upper Hiawatha Bed, which is mined at the SUFCo Mine No. 1. The Upper Hiawatha Bed averages 14 feet in thickness and is usually found about 25 feet above the Star Point/Blackhawk contact. Permeability within the Blackhawk Formation varies with sandstone units having greater primary permeability than other lithologic units.

Overlying the Blackhawk Formation is the Castlegate Sandstone which is the basal member of the Price River Formation. The Castlegate varies from 100 to 200 feet in thickness and is conglomeratic to medium-grained in texture and light gray to white in color. The Castlegate forms prominent yellow-brown cliffs and plateaus in the area. Primary permeability of this unit is significant. The Price River Formation (600 to 1000 feet in thickness) is a medium to coarse-grained

sandstone with occasional claystone interbeds. Sandstone units in the Price River have significant primary permeability.

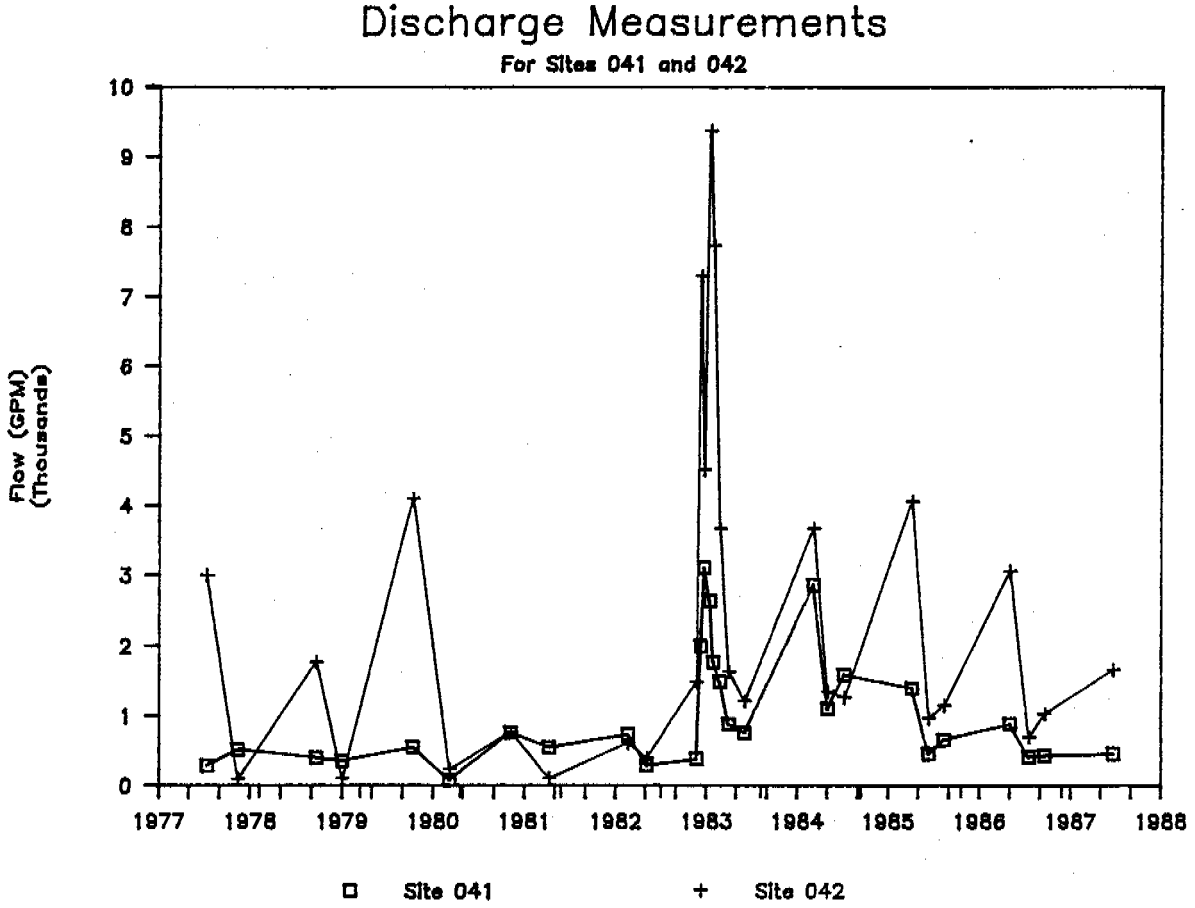
Unconsolidated deposits of Quaternary age are present along streams and generally consist of silts, sands and occasional gravels. The deposits have low to moderate permeability.

MINE AREA HYDROLOGY

The entire mine area is drained by Quitchupah Creek and its tributaries (Figure 1 and Plate 1). Quitchupah Creek has two major tributaries, the North Fork and the South Fork. These streams have their headwaters in the highland slopes of the White Mountains located northwest of the mine area. There are numerous ephemeral tributaries to the major stream system. These tributaries flow during periods of snowmelt and rainfall. Most springs in the area are present at the contact between the Castlegate Sandstone and the underlying Blackhawk Formation. A few springs are present at the contact between the Blackhawk Formation and underlying Star Point Sandstone Formation.

Surface Water Resources

Streamflows are closely related to winter snowpack accumulations and to summer thunderstorm activity. Spring and summer streamflows typically were greater when following winters with above average winter snowpack accumulations (Figure 2).



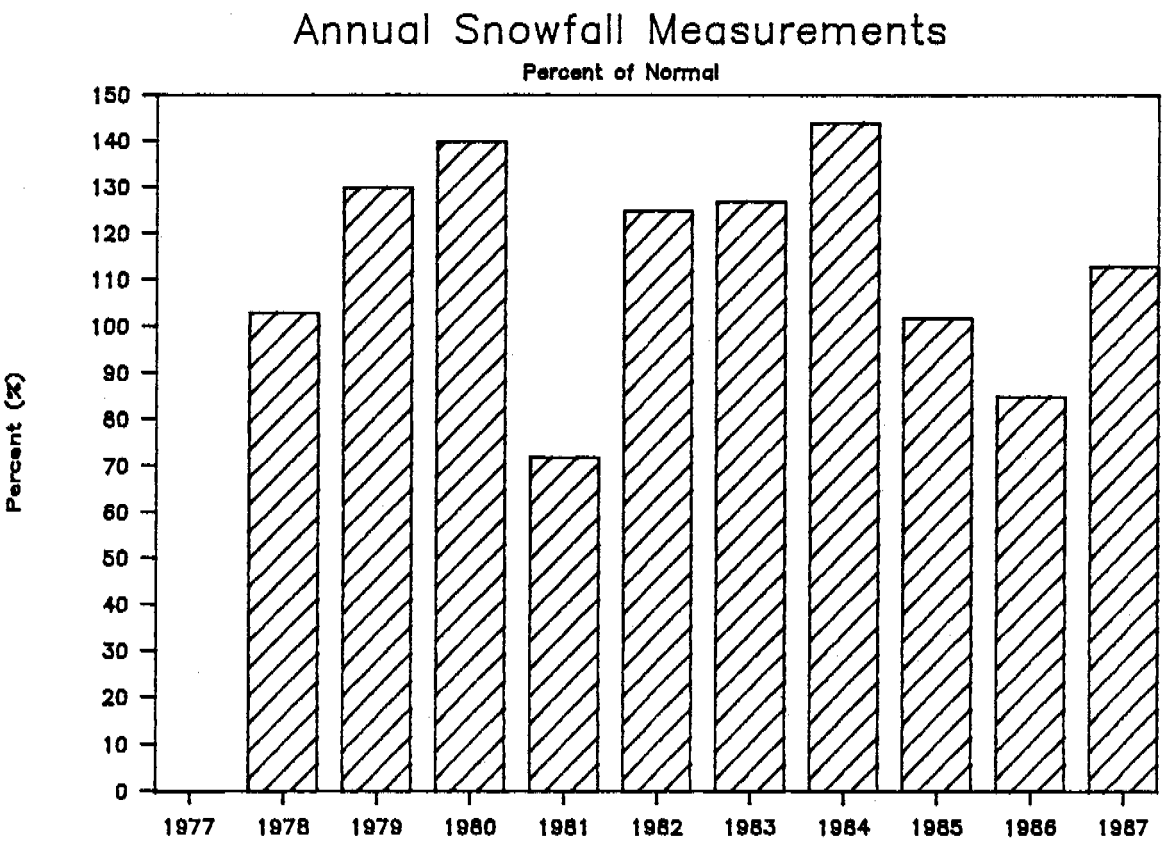


Figure 2: Relationship Between Snowpack Accumulations and Streamflow

Beginning in 1978, streamflow gaging stations were installed on the South Fork Quitchupah Creek above the canyon, on the North Fork Quitchupah Creek above the canyon and at the mouth. Various combinations of flumes, weirs and conventional stage/discharge types of stations were used with only limited success; that is, continuous flow records were obtained only intermittently. Peak flows associated with spring runoff and high intensity thunderstorms often washed out any physical structure and frequently changed the channel cross-section.

Surface water samples have been collected seasonally at several stream locations (Plate 1) for laboratory analysis. Since 1977, parameters measured were common cations and anions, nutrients and selected trace metals. Representative water quality data for area streams are in the Appendix.

Based on an examination of water quality data collected since 1977, the following conclusions are made:

1) Water in the area generally is of fair to good quality, is a calcium-magnesium-bicarbonate type, is alkaline and has low concentrations of nutrients and metals.

2) Streams sampled usually met Federal primary and secondary drinking water standards (Table 1) for constituents measured. However, total dissolved solids concentrations

TABLE 1

FEDERAL DRINKING WATER STANDARDS FOR PUBLIC WATER SUPPLIES

Parameter	Maximum Contaminant Levels for Inorganic Chemicals (mg/l)
Primary Standards(1)	
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate as N	10.
Selenium	0.01
Silver	0.05
Fluoride	1.4 - 2.4(2)
Secondary Standards(3)	**Recommended Maximum Contaminant Levels (mg/l)**
Chloride	250
Color	15 (color units)
Copper	1.0
Corrosivity	Non-corrosive
Iron	0.3
Manganese	0.05
Odor	Threshold odor number of 3
pH	6.5 - 8.5 Standard Units
Sulfate	250
Zinc	5.0
Total Dissolved Solids	500
Foaming agents	0.5

(1) 40 CFR Part 141 (Federal Register, Vol. 40, No. 248, December 24, 1975) and (Administrative Rules of Montana) ARM 16-2.14(10)-S14381.

(2) Maximum allowable concentration depends on annual average of maximum daily air temperatures at site of supply.

(3) 40 CFR Part 143 (Federal Register, Vol. 44, No. 140, July 19, 1979).

sometimes exceeded secondary drinking water standards. Total iron and manganese levels in a few samples exceeded secondary drinking water standards.

3) For parameters measured, waters sampled typically were better than required by Utah water quality standards (Table 2) for domestic use and aquatic wildlife.

4) None of the waters sampled exceeded recommended limits for livestock use (Table 3).

5) Stream water quality typically was slightly poorer in the fall (less dilution of dissolved substances) than in spring and early summer (Figure 3).

The sediment pond discharge site 066 (NPDES 002) is at the mine portal facilities site in East Spring Canyon. Total dissolved solids ranged from 210 mg/l to 2150 mg/l and were typically greater than for other surface or groundwaters in the area. Total suspended solids usually were less than 20 mg/l but sometimes exceeded 30 mg/l. The maximum TSS concentration reported was 194 mg/l. Except for iron, metals concentrations were low and were less than Federal (primary and secondary) and Utah drinking water standards.

TABLE 2. UTAH DIVISION OF HEALTH NUMERICAL STANDARDS FOR PUBLIC WATER SUPPLIES

Constituent	CLASSES											
	Domestic Source			Recreation & Aesthetics		Aquatic Wildlife				Agri-culture	Indus-try	Special
	1A	1B	1C	2A	2B	3A	3B	3C	3D	4	5	6
Bacteriological (No./100 ml)												
(30-day Geometric Mean) Maximum Total Coliforms	1	50	5,000	1,000	5,000	*	*		*	*		
Maximum Fecal Coliforms	*	*	2,000	200	2,000	*	*		*	*		
Physical												
Total Dissolved Gasses	*	*	*	*	*	(b)	(b)		*	*		
Minimum DO (mg/l) (a)	*	*	5.5	5.5	5.5	6.0	5.5		5.5	*		
Maximum Temperature	*	*	*	*	*	20°C	27°C		*	*		
Maximum Temp. Change	*	*	*	*	*	2°C	4°C		*	*		
pH	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0		6.5-9.0	6.5-9.0		
Turbidity increase (c)	*	*	*	10 NTU	10 NTU	10 NTU	10 NTU		15 NTU	*		
Chemical (Maximum mg/l)												
Arsenic, dissolved	.05	.05	.05	*	*	*	*		*	.1		
Barium, dissolved	1	1	1	*	*	*	*		*	*		
Cadmium, dissolved	.010	.010	.010	*	*	.0004(d)	.004(d)		*	.01		
Chromium, dissolved	.05	.05	.05	*	*	.10	.10		.10	.10		
Copper, dissolved	*	*	*	*	*	.01	.01		*	.2		
Cyanide	*	*	*	*	*	.005	.005		*	*		
Iron, dissolved	*	*	*	*	*	1.0	1.0		1.0	*		
Lead, dissolved	.05	.05	.05	*	*	.05	.05		*	.1		
Mercury, total	.002	.002	.002	*	*	.00005	.00005		.00005	*		
Phenol	*	*	*	*	*	.01	.01		*	*		
Selenium, dissolved	.01	.01	.01	*	*	.05	.05		*	.05		
Silver, dissolved	.05	.05	.05	*	*	.01	.01		*	*		
Zinc, dissolved	*	*	*	*	*	.05	.05		*	*		
NH_3 as N (un-ionized)	*	*	*	*	*	.02	.02		*	*		
Chlorine	*	*	*	*	*	.002	.01		*	*		
Fluoride, dissolved (e)	1.4-2.4	1.4-2.4	1.4-2.4	*	*	*	*		*	*		
NO_3 as N	10	10	10									
Boron, dissolved	*	*	*	*	*	*	*		*	.75		
H_2S	*	*	*	*	*	.002	.002		*	*		
TDS (f)	*	*	*	*	*	*	*		*	1200		
Radiological (Maximum pCi/l)												
Gross Alpha	15	15	15	*	*	15(g)	15(g)		15(g)	15(g)		
Radium 226, 228 combined	5	5	5	*	*	*	*		*	*		
Strontium 90	8	8	8	*	*	*	*		*	*		
Tritium	20,000	20,000	20,000	*	*	*	*		*	*		
Pesticides (Maximum ug/l)												
Endrin	.2	.2	.2	*	*	.004	.004		.004	*		
Lindane	4	4	4	*	*	.01	.01		.01	*		
Methoxychlor	100	100	100	*	*	.03	.03		.03	*		
Toxaphene	5	5	5	*	*	.005	.005		.005	*		
2, 4-D	100	100	100	*	*	*	*		*	*		
2, 4, 5-TP	10	10	10	*	*	*	*		*	*		
Pollution Indicators (g)												
Gross Beta (pCi/l)	50	50	50	*	*	50	50		50	50		
BOD (mg/l)	*	*	5	5	5	5	5		5	5		
NO_3 as N (mg/l)				4	4	4	4		*	*		
FOS as P (mg/l)(h)	*	*	*	.05	.05	.05	.05		*	*		

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS (SEE APPENDIX D)

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS

STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS

* Insufficient evidence to warrant the establishment of numerical standard. Limits assigned on case-by-case basis.

(a) These limits are not applicable to lower water levels in deep impoundments.

(b) Not to exceed 110% of saturation.

(c) For Classes 2A, 2B, 3A, and 3B at background levels of 100 NTUs or greater, a 10% increase limit will be used instead of the numeric values listed. For Class 3D at background levels of 150 NTUs or greater, a 10% increase limit will be used instead of the numeric value listed. Short term variances may be considered on a case-by-case basis.

(e) Maximum concentration varies according to the daily maximum mean air temperature.

Temp. °C	mg/l
12.0 and below	2.4
12.1 to 14.6	2.2
14.7 to 17.6	2.0
17.7 to 21.4	1.8
21.5 to 26.2	1.6
26.3 to 32.5	1.4

(f) Total dissolved solids (TDS) limit may be adjusted on a case-by-case basis.

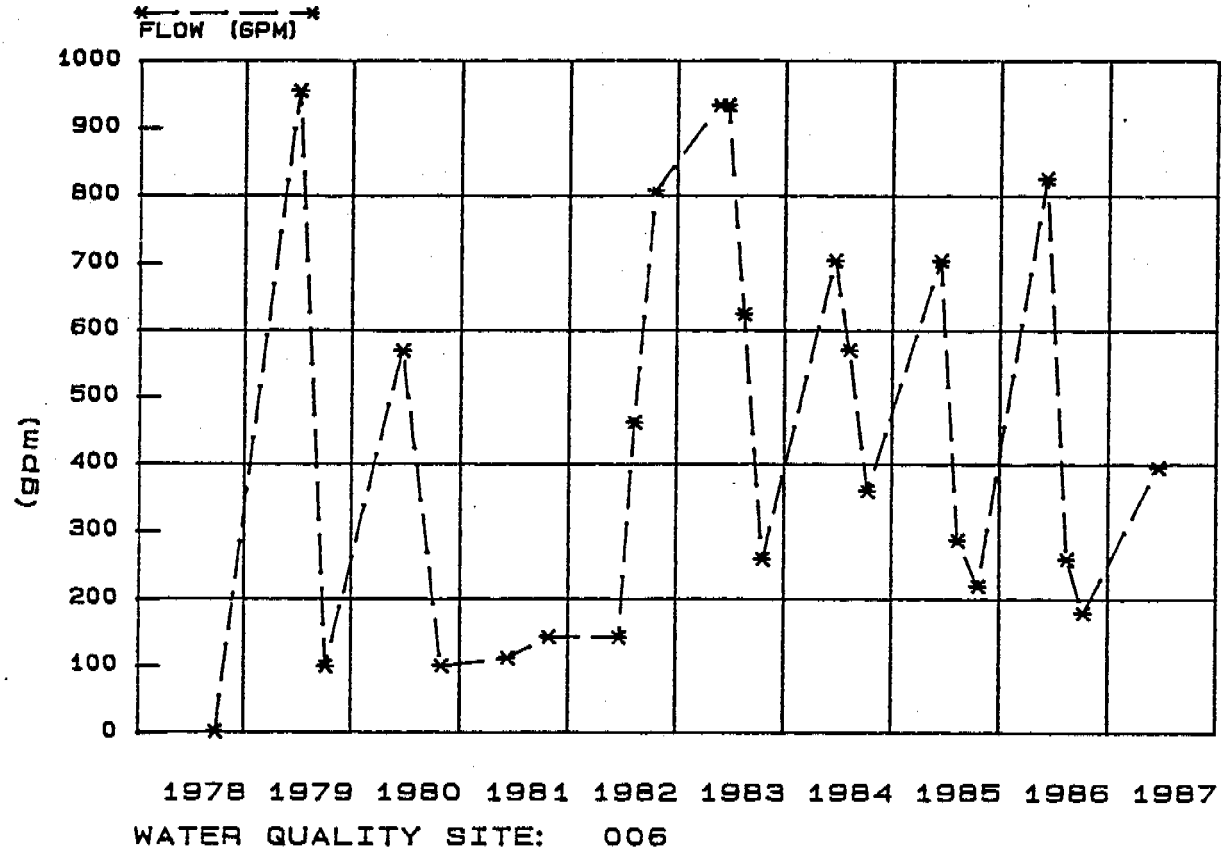
(g) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

TABLE 3

RECOMMENDED LIMITS FOR LIVESTOCK WATER

Parameter	Concentration - mg/l
$NO_3 + NO_2$ as N	100
Total Dissolved Solids	3000-5000
Boron	5
Aluminum	5
Cadmium	0.05
Copper	0.5
Fluoride	2.0
Iron	No Recommendation
Lead	0.1
Mercury	0.010
Selenium	0.05
Vanadium	0.1
Zinc	25

Source: U. S. Environmental Protection Agency, 1973. Water Quality Criteria 1972. EPA-R-73-023.



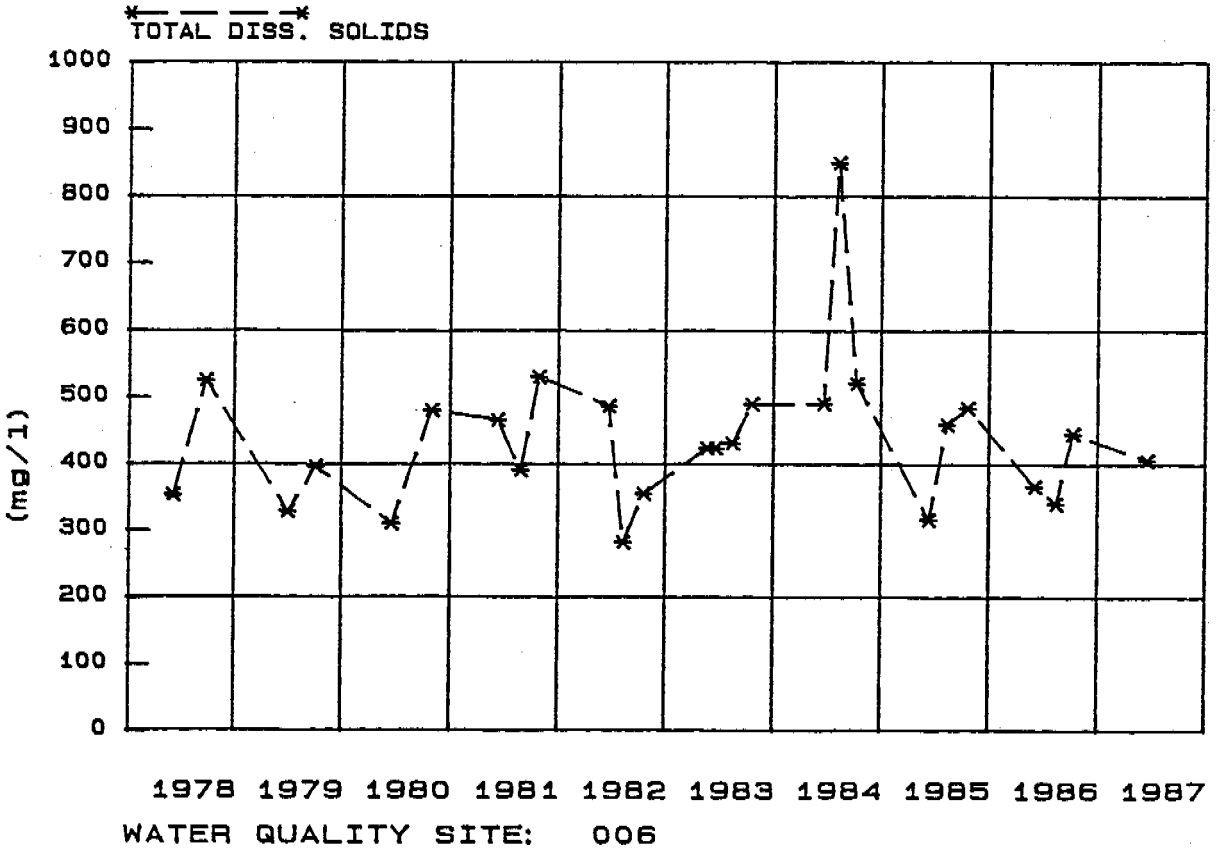
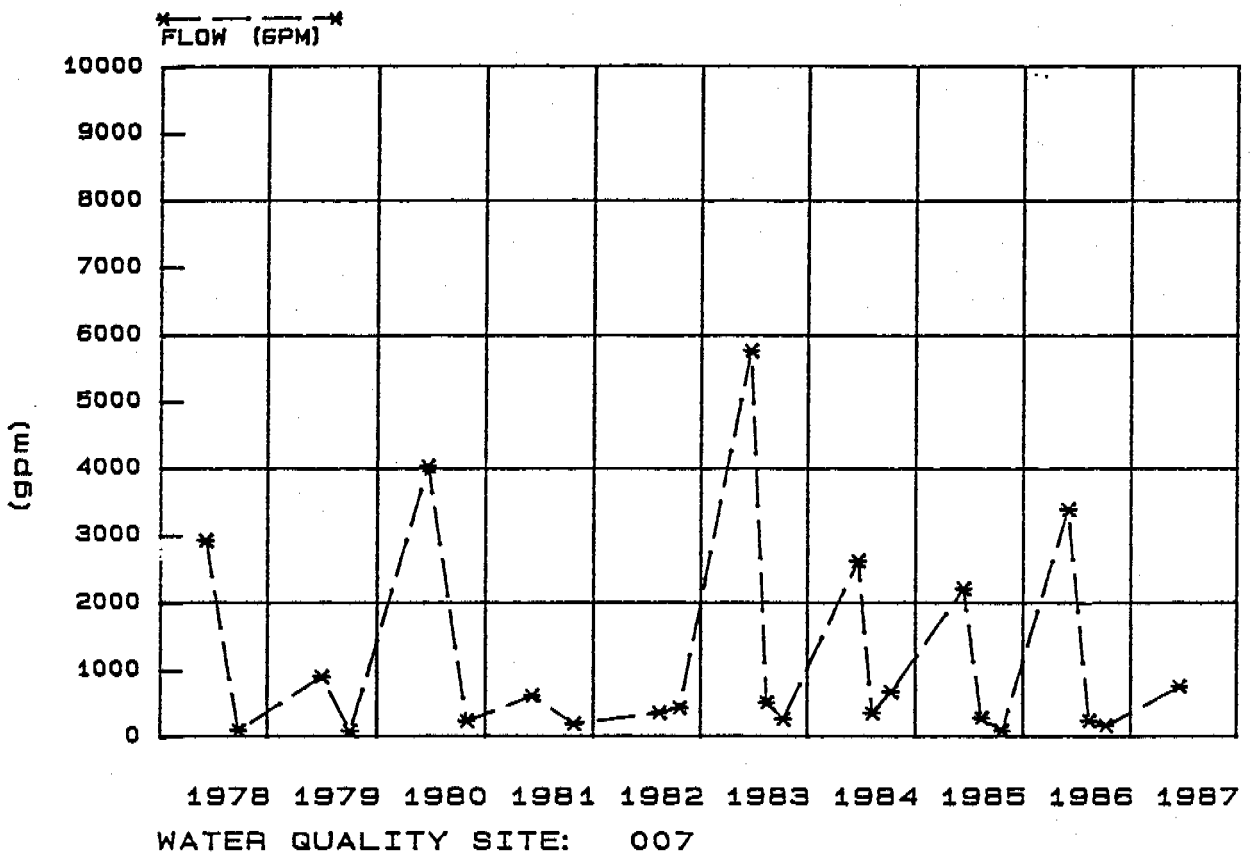


Figure 3: Relationship Between Discharge and Total Dissolved Solids For Selected Sites



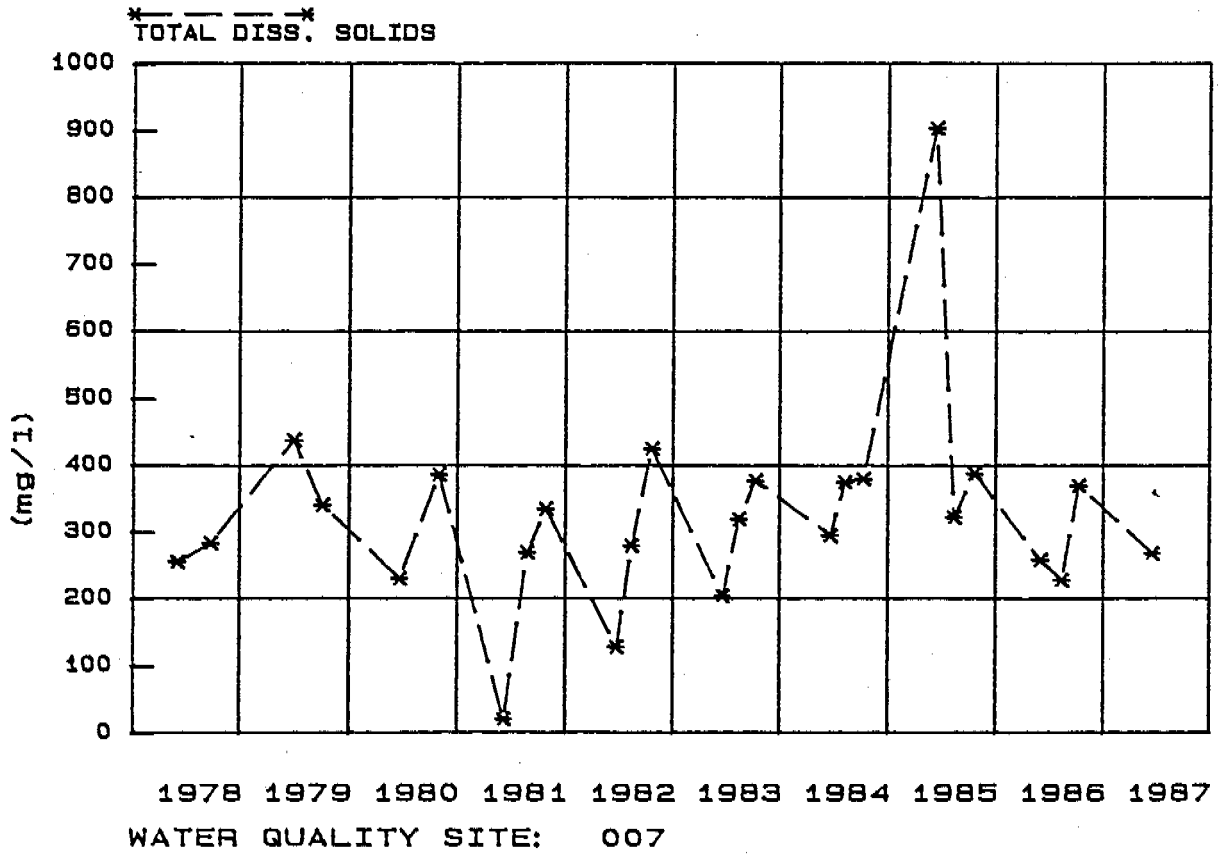
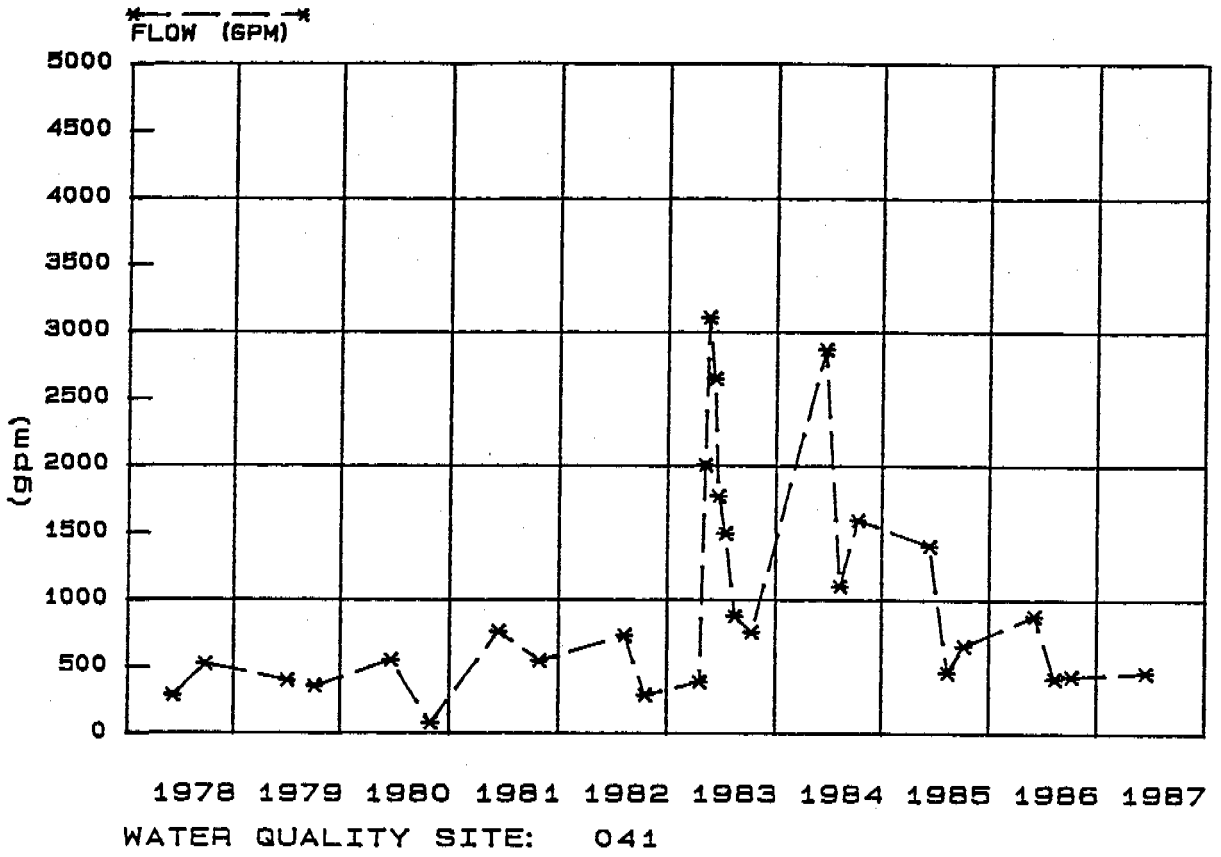


Figure 3, Continued



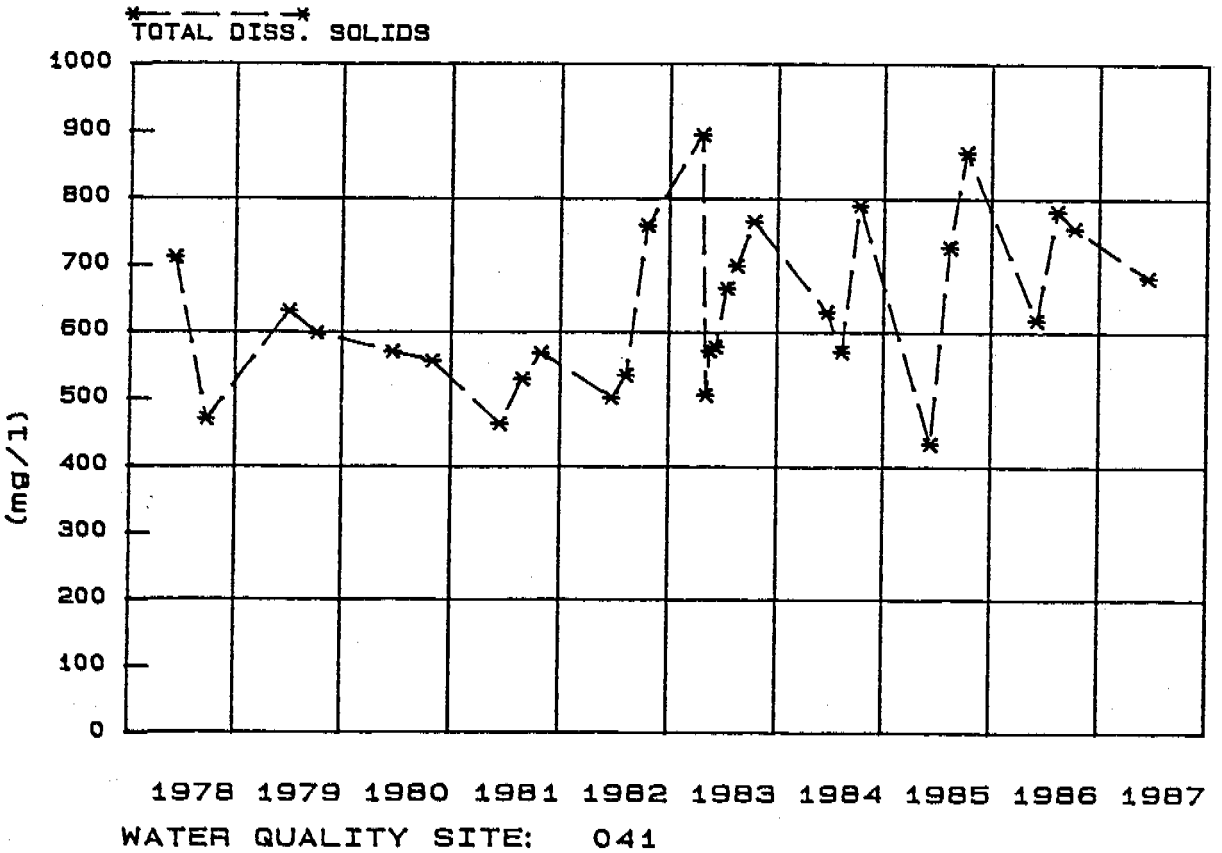
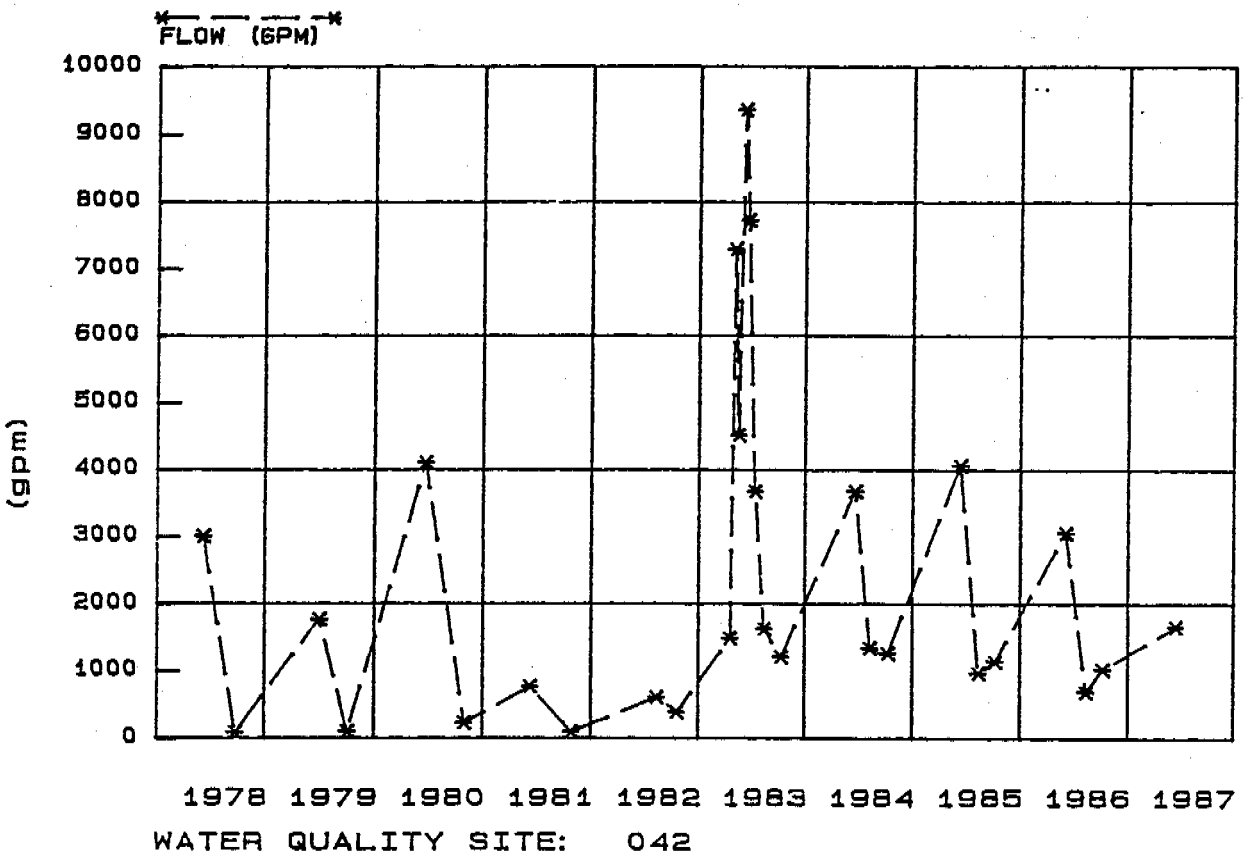


Figure 3, Continued



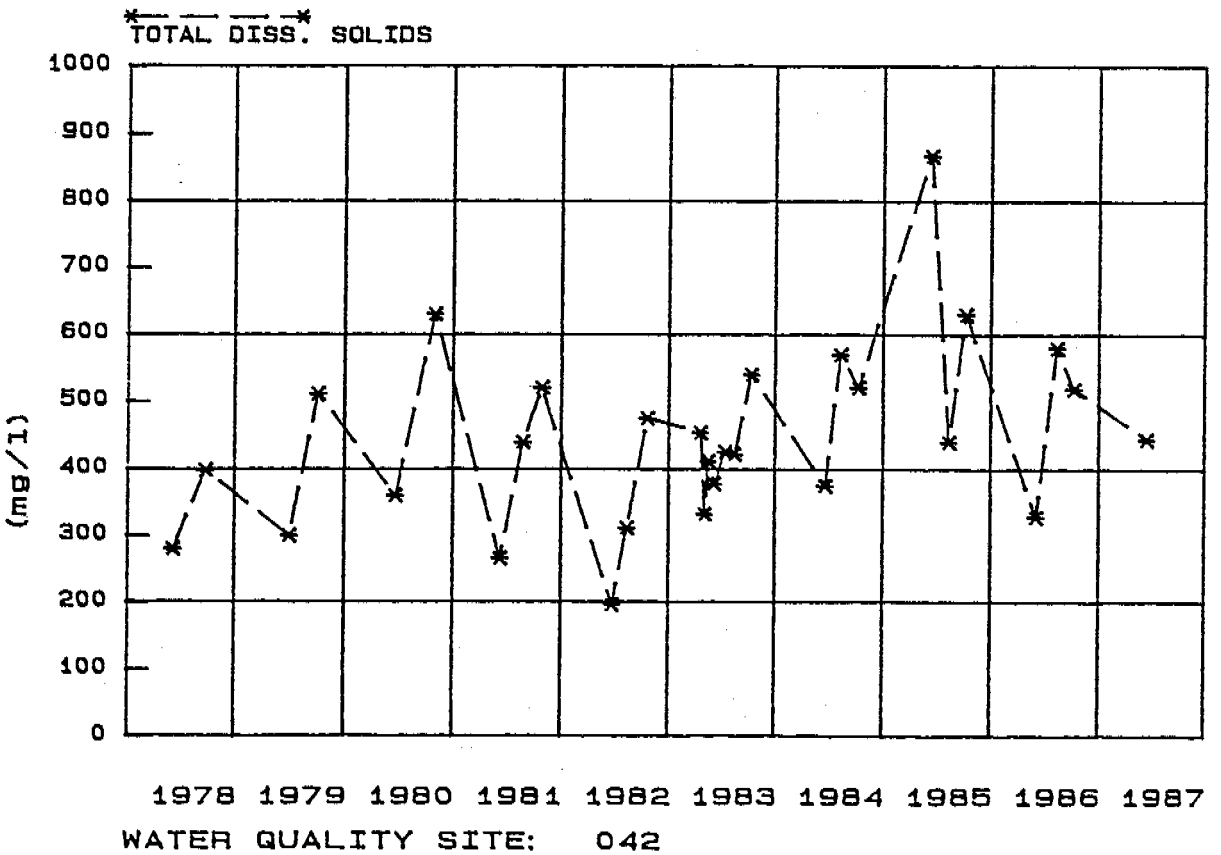
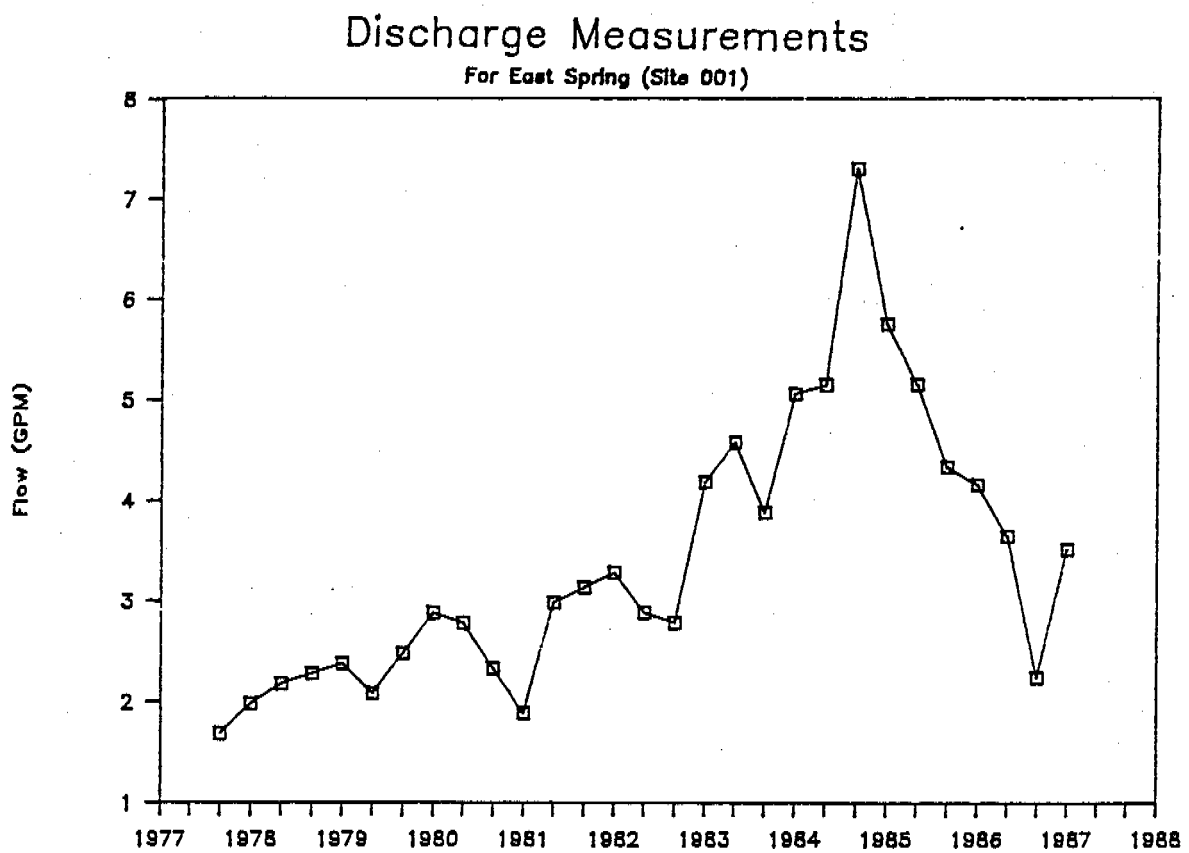


Figure 3, Continued

Groundwater Resources

Annual drainage traverses were made in late spring and early fall for the years 1977 through 1983 to observe springs and seeps in the mine area. Observations indicate most spring flows exhibit little seasonal or year-to-year variation. This suggests extensive aquifer systems which do not reflect short-term variations in precipitation. Springs and small seeps also are generally dry a short distance downstream from their appearance. East Spring has been developed for stock use and because of its importance for that use, has been monitored throughout the period 1977 to 1987. Since 1977, East Spring (Site 001) has shown a gradual response to annual climatic fluctuations indicating the spring is connected to a relatively large groundwater system, possibly in combination with a smaller, shallower groundwater system (Figure 4). Mining subsidence beneath East Spring occurred in June 1985 and probably caused the decrease in discharge noted from June 1985 through early 1987. The discharge has not, however, dropped below the discharge rates noted in 1977 and 1978. Monitoring during the second quarter of 1987 suggests spring flows may again be increasing, perhaps as a result of adjustment in the hydrologic regimen of the subsided area.

Results of exploratory drilling, observation wells, and well and spring inventories show geological formations in the SUFCo mine area contain limited amounts of groundwater and have a poor ability to conduct groundwater or to yield water to wells. The hydrological system, as it is now known, consists of low permeability sandstones



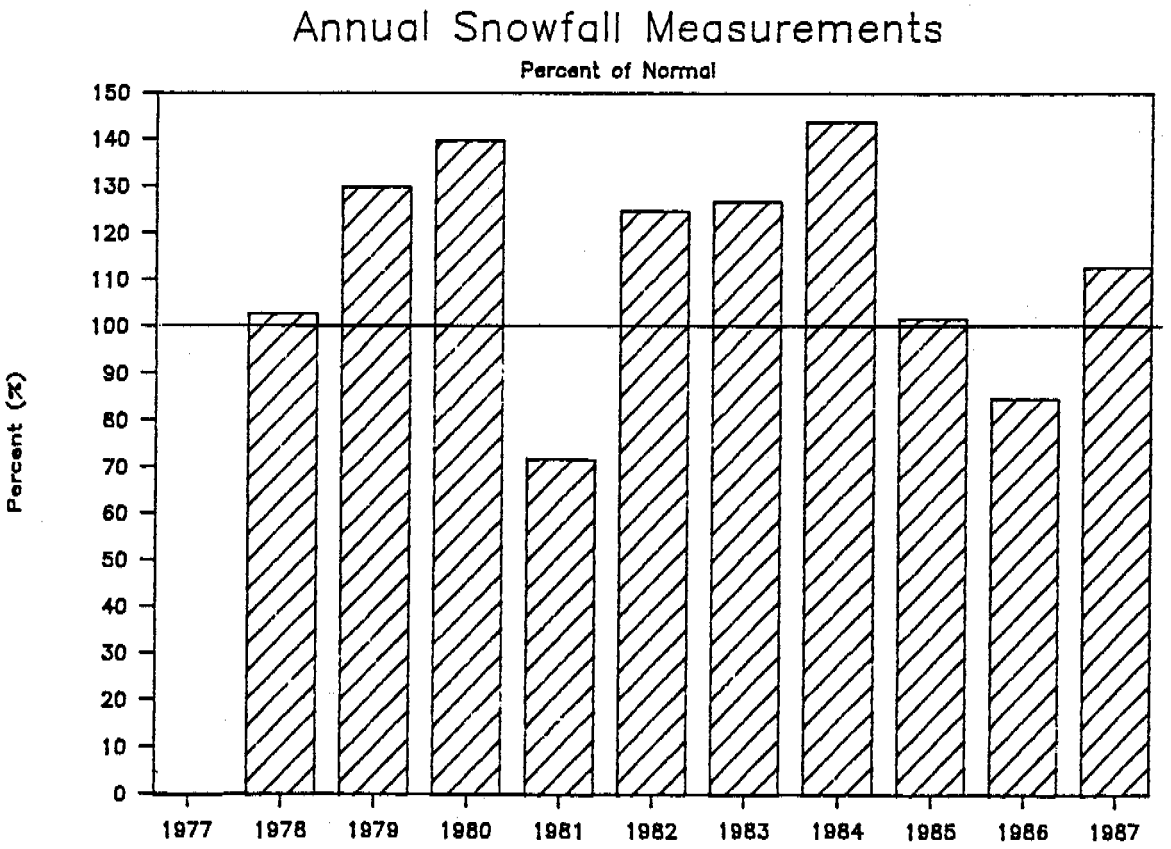


Figure 4: Relationship Between Discharge and Snowpack Accumulations at East Spring

that have some groundwater in storage but have small groundwater flows. Flows from springs in the area are small but tend to be steady.

Recharge of groundwater is from streams and infiltation of precipitation into sandstone units. Groundwater discharge is to springs, streams and areas of evaporation and transpiration. There is little baseflow to streams in the area which supports the conclusion of a limited flow of groundwater.

Three groundwater observation wells were constructed in 1978 and four in 1979. Additional wells were installed in 1980 and 1981 (Table 4). Water level data from these holes has been collected to determine the depth to the water table (Figure 5) and to provide information on directions of groundwater movement. These data show:

1) Recent water levels in Well US-77-8 have stabilized at elevations approximately 4 feet higher than measured in 1978 through 1981.

2) Well US 77-9 was first noted dry in 1982 and has continued to be dry to date.

3) 1987 water levels in Well US-79-13 were higher (approximately 20 feet) than measured in previous years.

Depth to Coal

TABLE 4. CHARACTERISTICS OF OBSERVATION WELLS (Revised February 15, 1982)

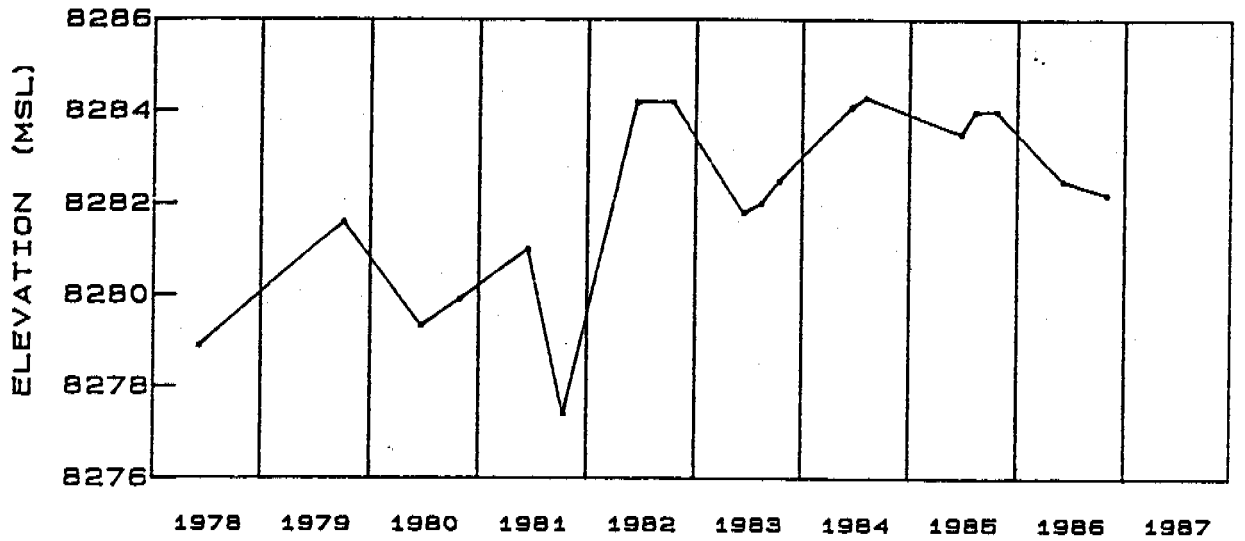
Obs. Well No.	Location*	Total Drilled Depth (ft)	Total Depth Measured (ft)	Total Depth Cased (ft)	Casing I.D. (in.)	Perforations (ft)	Elevation Casing Top	Formation Monitored	State Plane Coordinates E	State Plane Coordinates N
US-77-7	21S05E31ABC 1220 8495 7442	294		-	1¼	-	8494	-	-	-
US-77-8	22S05E6BB 961 1140 8422 7471	NM		160	1¼	110	8422	Castlegate	2,029,925	220,450
US-77-9	21S04E36DBB 1075	NM		100	1¼	75	8379	Upper Blackhawk/ Lower Castlegate	2,028,200	220,550
US-79-9	22S05E8BB [illegible] 970 [illegible]	860		860	2	20	8540	U-Hia Coal	2,031,540	214,460
US-79-10	22S05EBAC 858 990 8552 7694	885		880	2	20	8551	U-Hia Coal	2,033,870	214,590
US-79-12	22S05E5CAD 879 990 8621 7642	860		860	2	20	8521	U-Hia Coal	2,033,540	216,110
US-79-13	22S05E5CB 805 1010 8526 7621	705		705	2	20	8526	Sandstone in Blackhawk	2,032,000	217,320
US-80-2	21S04E36CDA 207		200.7	200	4	40		Castlegate		
US-80-4	21S04E36DAC 242		243.6	240	4	40		Castlegate		
NO US-81-1	21S05E30CB 1159 1300 8490 7331			1300	2	20		U-Hia Coal		
NO US-81-2	21S04E25DCD 1337 1460 8686 7352			1460	2	20		U-Hia Coal		
US-81-3	21S04E25CCC 1732 1980 9026 7294			1940	6 (0-760 ft.) 2 (760-1940 ft.)	20		U-Hia Coal		
US-81-4	21S04E25BBB 1496 1300 8380 7182			1300	6**	20(1200-1220 ft.)		U-Hia Coal		

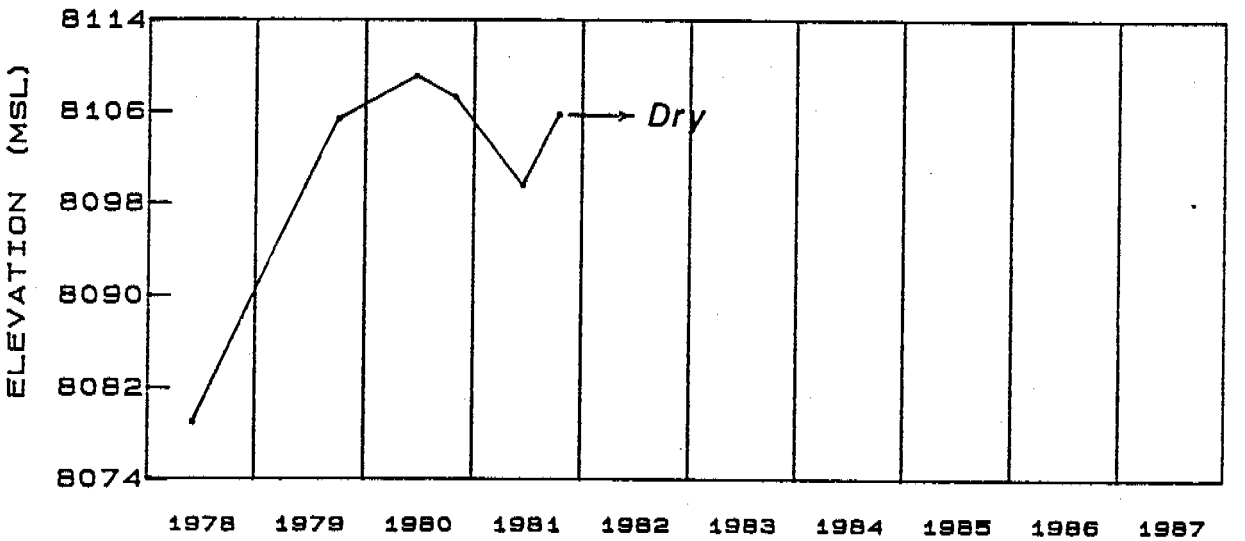
* See Appendix for discussion of geographical location of features.

**Revised according to Trimble (1982, pers. comm.)

Source: Coastal States Energy Company

~~Well completion data~~ monitoring data





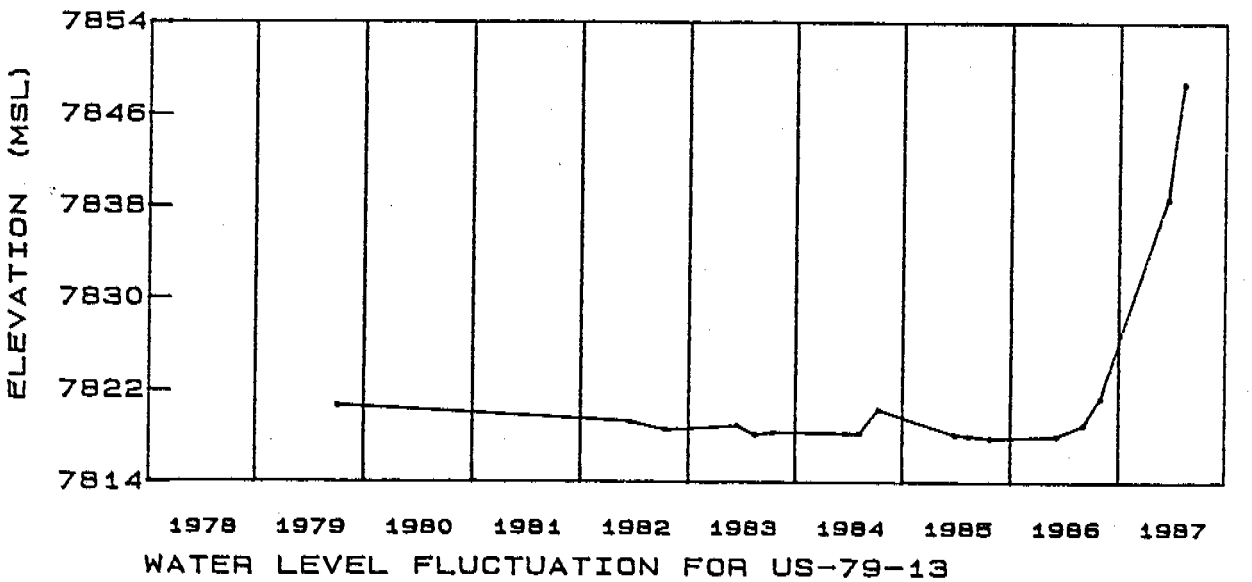
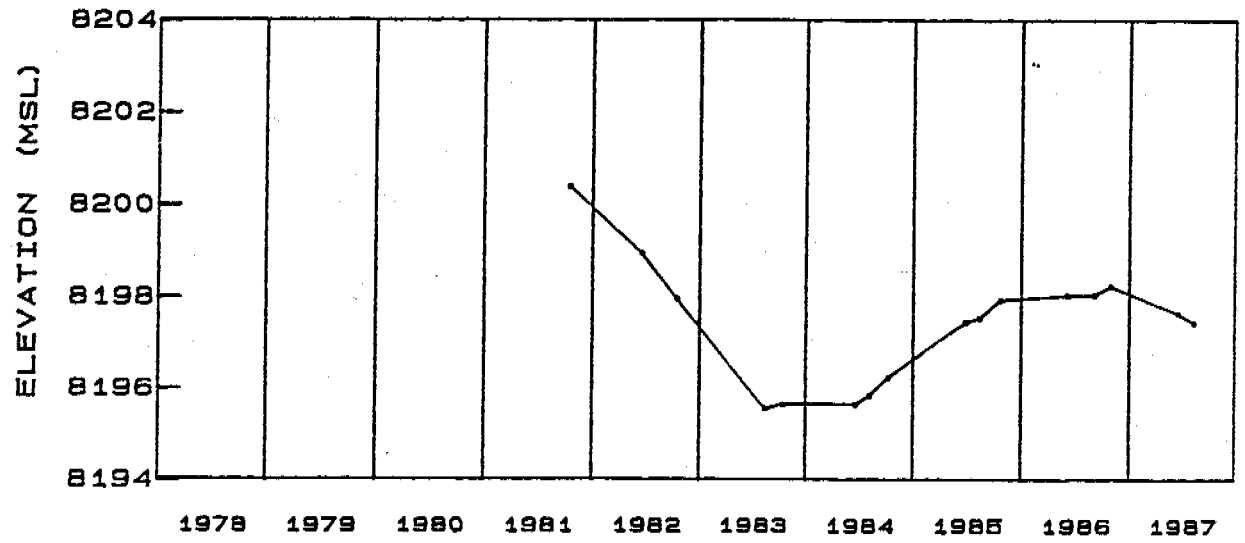
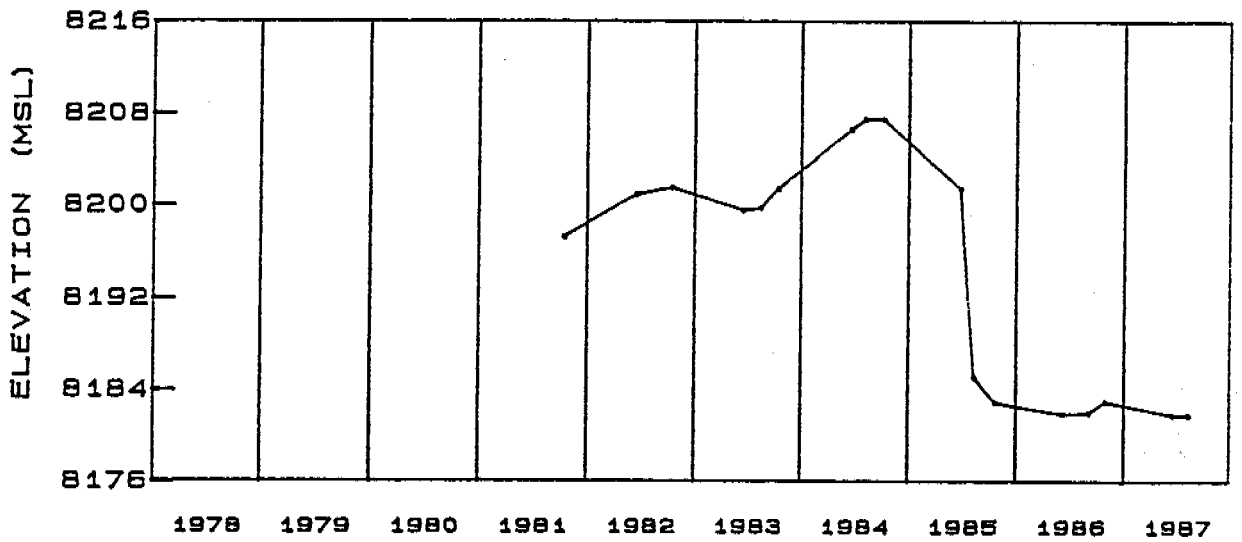


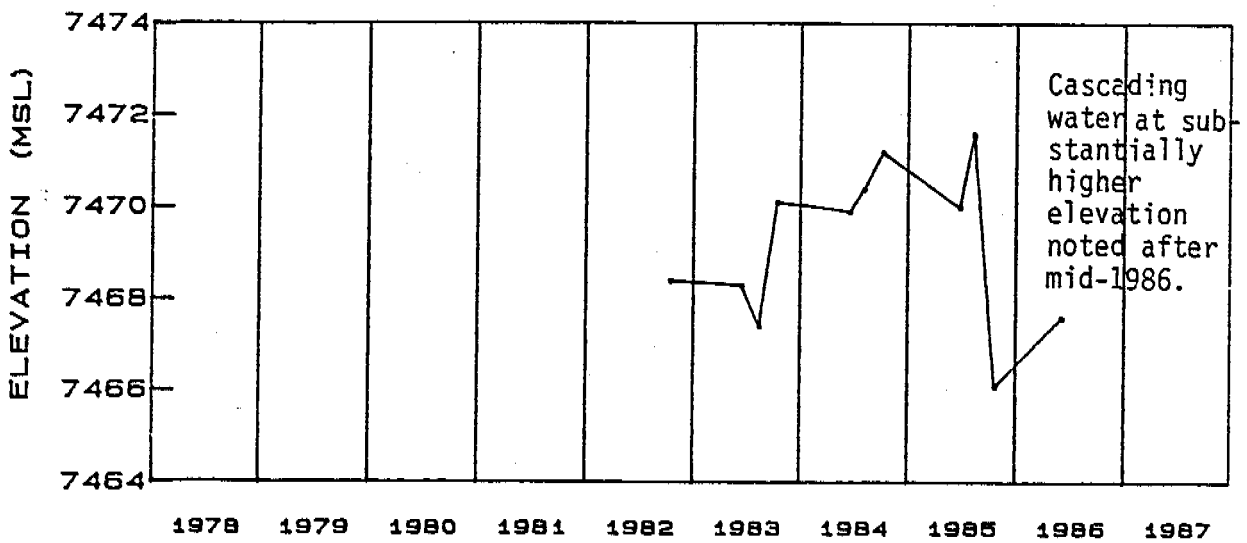
Figure 5: Water Levels in Monitoring Wells



WATER LEVEL FLUCTUATION FOR US-80-2

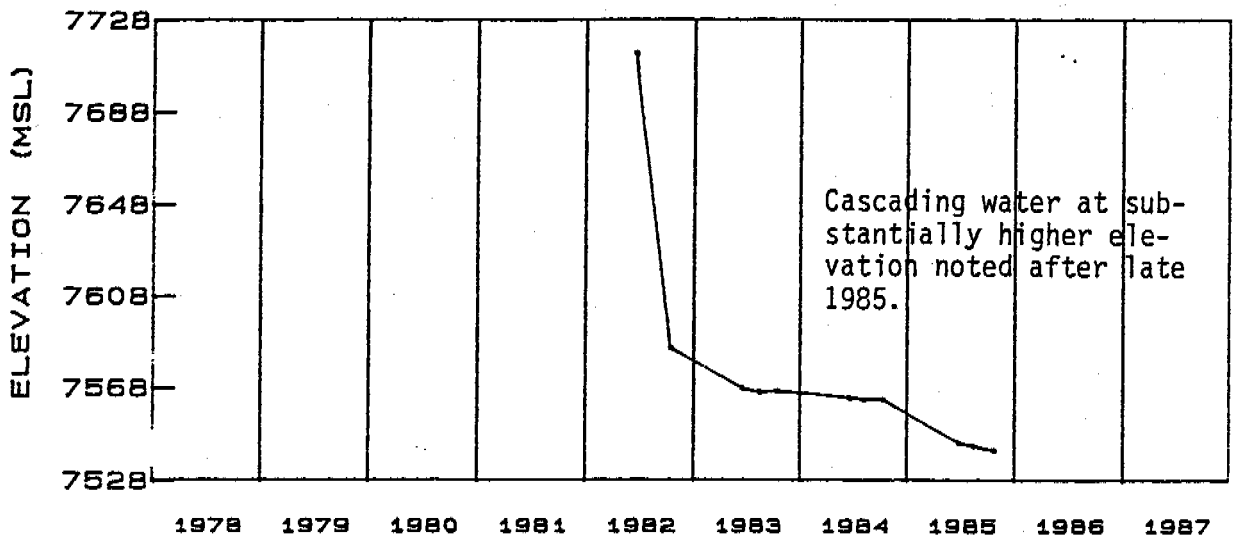


WATER LEVEL FLUCTUATION FOR US-80-4

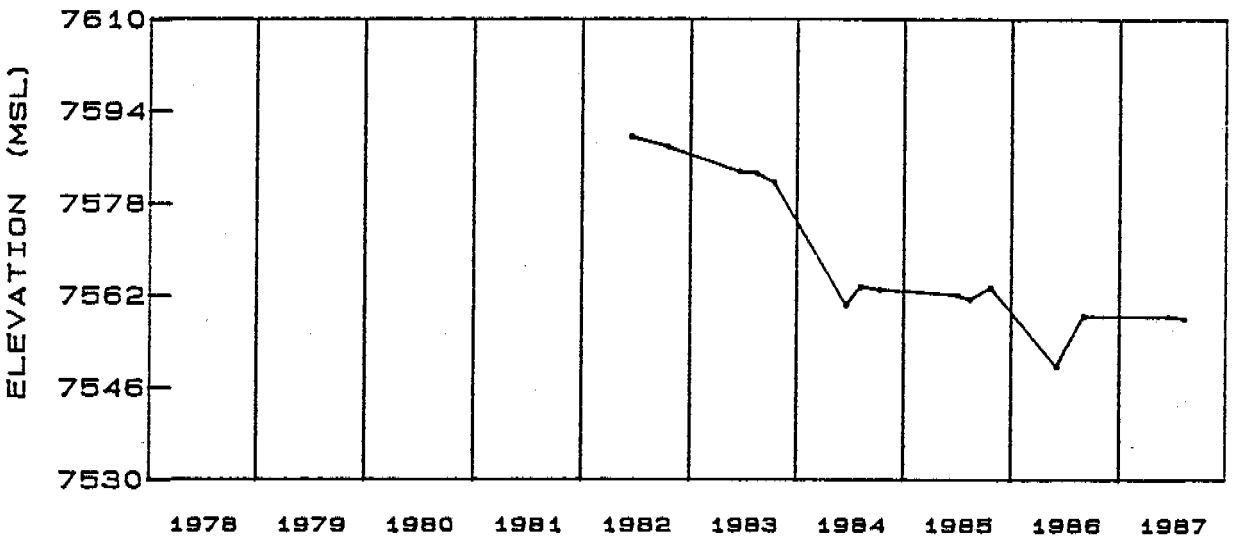


WATER LEVEL FLUCTUATION FOR US-81-1

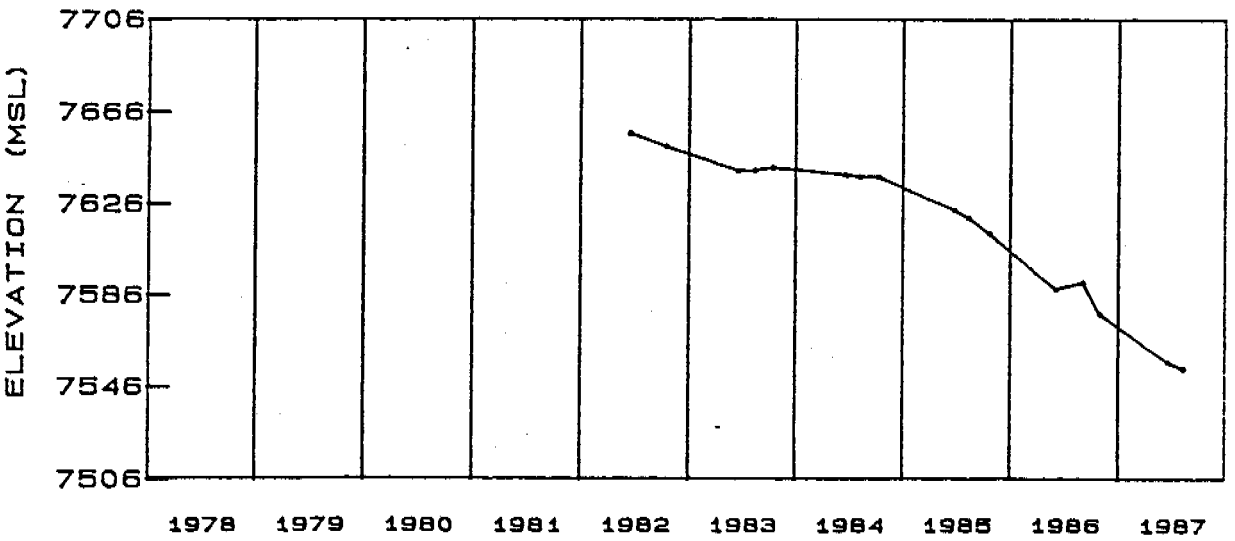
Figure 5: Continued



WATER LEVEL FLUCTUATION FOR US-81-2



WATER LEVEL FLUCTUATION FOR US-81-3



WATER LEVEL FLUCTUATION FOR US-81-4

Figure 5: Continued

4) Water levels in Well US-80-4 declined approximately 16 to 18 feet following subsidence in the area of the well in mid-1985.

5) Beginning in 1986, reported water levels were approximately 500 feet higher than noted in previous years. Erratic readings noted at the higher level are believed to be the result of a joint failure in the casing, which then allows water to enter the casing at this level and cascade down the pipe.

US 81-4

6) Declines in water levels noted in Wells US-81-2, US-81-3 and particularly US-81-4 may be due to dewatering of the Upper Hiawatha coal bed by mining. Beginning in June 1986, cascading water was noted to be entering Well US-81-2 at approximately 450 higher than the previously measured water level. Because the casing has apparently failed at the higher level, Well US-81-2 is no longer considered reliable.

Groundwater is present in the Hiawatha Coal Bed and underground mine workings at SUFCo have encountered significant groundwater inflows. Source of groundwater in the mine workings is not well known but probably is from groundwater stored in the coal seam and from vertical movement from overlying sandstone units.

Groundwater intercepted within the mine was discharged into East Spring Canyon at Site 021 (NPDES 001) from 1977 through September 1982. In September 1982 this discharged was rerouted to the Quitchupah Portal and is now discharged to North Fork Quitchupah Creek at NPDES 003 (near Site 070). This discharge is alkaline and typically contains less than 600 mg/l total dissolved solids. Total iron concentrations are usually less than 0.3 mg/l. Total suspended solids concentrations generally range from 2 mg/l to 25 mg/l. Oil and grease concentrations typically are less than 5 mg/l.

Laboratory analysis of groundwater samples collected from the mine discharge (NPDES 001 and NPDES 003) and from East Spring (Site 001) indicate groundwater from formations above the Mancos Formation are calcium-magnesium-sodium bicarbonate type waters with total dissolved solids concentrations of less than 1000 mg/l and trace metals concentrations which typically are less than Federal and State drinking water standards.

APPENDIX

REPRESENTATIVE WATER QUALITY

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	001	001	001	001	001	001	001A	002	003	005
SAMPLE DATE	08/14/85	10/22/85	06/04/86	08/13/86	10/09/86	06/18/87	07/15/75	07/31/75	07/15/75	06/04/78
LOCATION	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E				
LOCATION	36DCD	36DCD	36DCD	36DCD	36DCD	36DCD				
DESCRIPTION	EAST	EAST	EAST	EAST	EAST	EAST	WEST	MAIN	QUIT CK	SEEP IN E.
DESCRIPTION	SPRING	SPRING	SPRING	SPRING	SPRING	SPRING	SPRING	SUMP	AT MINE	SPR CANYON
REMARKS	1300 HRS	1230 HRS	1020 HRS	1400 HRS	1210 HRS	1000 HRS				
PHYSICAL PARAMETERS										
FLOW (GPM)	5.17	4.35	4.17	3.66	2.26	3.53				1
WATER TEMPERATURE (C)	6	6	5.5	6	6	6			16.7	9.0
SPEC. COND. (UMHOS/CM) FIELD	593	420	451	485	417	454				
SPEC. COND. (UMHOS/CM) LAB	432	455	461	438	467	489	624.0	566.0	1018.0	620
TURBIDITY (JTU) LAB							1.20	24.0	0.95	
PH FIELD	7.0	6.7	7.0	7.2	6.1	7.3				7.3
PH LAB	7.50	7.45	7.55	7.50	8.00	7.60	7.70	7.70	7.69	
TURBIDITY (NTU) FIELD	6.3	3.2								
TURBIDITY (NTU) LAB	5.00	35.48	0.84	0.05	0.17	2.43				
TOTAL SUSP. SOLIDS							1.5	75.8	7.6	5
TOTAL DISS. SOLIDS MEAS.	280	266	242	220	268	270	406	368.0	662.0	406
OXYGEN (O) DISS							6.50	7.80	6.9	
COMMON IONS										
TOTAL HARDNESS AS CACO3	205	205	220	216	216	220	266.0	246.0	406.0	
CALCIUM (CA)	51.20	60.00	49.60	57.60	52.80	72.00	60.80	50.40	86.40	76.0
MAGNESIUM (MG)	18.50	13.20	23.00	17.30	20.20	9.60	27.36	28.80	45.60	43.2
SODIUM (NA)	45.00	10.70	11.81	13.51	9.20	12.76	1.84	2.00	16.70	22.5
POTASSIUM (K)	4.90						1.36	1.69	3.14	1.60
ACIDITY AS CACO3	18.90	13.70	<0.01	2.50	2.50	4.00				
ALKALINITY AS CACO3 (LAB)	180	260	193	190	192	190				
BICARBONATE (HCO3) (LAB)	219.6	268.4	235.0	231.8	185.4	233	283.60	237.5	436.30	410
CARBONATE AS CACO3 (LAB)							234.0	196.0	360.0	
CARBONATE AS CO3 (LAB)	<0.01	<0.01		<0.10	24.00	<0.01	<0.01	<0.01	<0.01	<0.01
HYDROXIDE (OH)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
SULFATE (SO4)	27	20	29	22	23	25	25.0	40.50	58.50	42
CHLORIDE (CL)	21.6	19.9	23.0	20.1	1.0	23.0	8.0	10.0	18.0	30
FLUORIDE (F)							0.15	0.13	0.27	0.26
NUTRIENTS										
NITRATE (NO3-N)	0.41	0.44	0.39	0.38	0.41	0.52	0.11	0.13	0.13	
NITRATE + NITRITE AS N										0.02
KJELDAHL NITROGEN AS N										0.12
ORTHO-PHOSPHATE (PO4-P)							0.13	0.24	0.28	0.022
TOTAL PHOSPHATE (PO4)	0.05	0.03	0.24	0.03	0.12	<0.04				
TRACE ELEMENTS										
ALUMINUM (AL) TOTAL							0.05	0.30	0.06	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	001	001	001	001	001	001	001A	002	003	005
SAMPLE DATE	08/14/85	10/22/85	06/04/86	08/13/86	10/09/86	06/18/87	07/15/75	07/31/75	07/15/75	06/04/78
TRACE ELEMENTS										
ARSENIC (AS) TOTAL							<0.01	<0.01	<0.01	<0.001
BARIUM (BA) TOTAL	0.05	0.07	0.06	0.07	0.07	0.06	0.04	0.03	0.07	
BORON (B) TOTAL	0.050	0.230	0.038	0.880	0.050	0.090	<0.01	<0.01	<0.01	
CADMIUM (CD) TOTAL							0.002	<0.001	<0.001	<0.001
CHROMIUM (CR)							<0.01	<0.01	<0.01	
COPPER (CU) TOTAL							<0.01	<0.01	<0.01	
IRON (FE) TOTAL	0.06	0.28	0.02	0.11	0.04	0.02	0.25	0.24	0.25	0.011
IRON (FE) DISS	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	0.10	0.18	0.19	
LEAD (PB) TOTAL							0.01	<0.01	0.02	
MANGANESE (MN) TOTAL	<0.02	0.02	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.03	0.015
MANGANESE (MN) DISS	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01				
MERCURY (HG) TOTAL							<0.001	<0.001	<0.01	
SELENIUM (SE) TOTAL							<0.01	<0.01	<0.01	<0.001
SILVER (AG) TOTAL							<0.001	<0.001	<0.001	
ZINC (ZN) TOTAL							<0.01	<0.01	0.03	
BACTERIOLOGICAL PARAMETERS										
TOTAL COLIFORM (NO./100ML)							<3	<3	<3	
5 - DAY BOD							1.6	1.5	2.0	
ORGANIC PARAMETERS										
PHENOLS							<0.001	<0.001	<0.001	
OTHER PARAMETERS										
SILICA (SIO2)										9.4
SILICA (SI)							12.50	8.50	4.50	
CYANIDE (CN)							<0.01	<0.01	<0.01	
SURFACTANTS							<0.01	<0.01	<0.01	

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	007	007	007	007	007	007	007	007	007	007
SAMPLE DATE	10/12/83	06/21/84	08/09/84	10/11/84	06/13/85	08/14/85	10/22/85	06/02/86	08/13/86	10/09/86
LOCATION	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E	21S04E
LOCATION	13ADC	13ADC	13ADC	13ADC	13ADC	13ADC	13ADC	13ADC	13ADC	13ADC
DESCRIPTION	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT
DESCRIPTION	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN	CK ABV CYN
REMARKS	1430 HRS	0945 HRS	1520	0900 HRS	0940 HRS	1020 HRS	1040 HRS	1230	1130 HRS	1015 HRS
PHYSICAL PARAMETERS										
FLOW (GPM)	269	2630	359	687	2220	287	94	3390	247	175
WATER TEMPERATURE (C)	12	7	21	5	10	13	0.5	14	17	15
SPEC. COND. (UMHOS/CM) FIELD	640	525	555	621	409	680	638	412	531	576
SPEC. COND. (UMHOS/CM) LAB	580	450	580	500	1384	508	677	428	474	618
TURBIDITY (JTU) FIELD	100+									
PH FIELD	7.7	7.6	7.8	7.9	7.5	8.0	7.6	7.6	8.3	7.4
PH LAB	7.60	7.85	7.70	8.00	7.80	8.20	8.05	8.40	8.20	8.20
TURBIDITY (NTU) FIELD		100+	93	100+	100+	29	76			
TURBIDITY (NTU) LAB	550.00	880	200	80.00	22.00	76.32	77.42	690	38.71	51.67
TOTAL DISS. SOLIDS MEAS.	377	295	375	380	904	322	388	258	228	370
COMMON IONS										
TOTAL HARDNESS AS CACO3	262	210	260	335	720	208	264	216	200	248
CALCIUM (CA)	56.00	80.00	44.00	60.00	100.00	44.80	60.00	58.40	42.40	59.20
MAGNESIUM (MG)	29.28	2.40	36.00	44.40	188.00	23.00	27.40	16.80	22.60	24.00
SODIUM (NA)	41.00	24.00	36.30	35.60	41.00	60.00	42.40	1639	31.37	39.50
POTASSIUM (K)	2.1	2.0			6.90	6.80				
ACIDITY AS CACO3	28.00	52.00	17.00	19.00	22.00	13.10	21.00	<0.01	1.20	1.20
ALKALINITY AS CACO3 (LAB)	278	232	260	270	404	238	290	182	212	248
BICARBONATE (HCO3) (LAB)	339.16	283.0	317.2	329.4	493.0	290.4	353.8	200.0	258.6	278.2
CARBONATE AS CO3 (LAB)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.10	12.00
HYDROXIDE (OH)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SULFATE (SO4)	48	28	39	46	475	36	47	88	31	124
CHLORIDE (CL)	20.00	6.4	16.8	17.0	86.0	19.7	22.8	4.1	13.9	4.4
NUTRIENTS										
NITRATE (NO3-N)	0.02	0.06	0.08	1.39	2.03	0.09	<0.01	0.15	0.05	0.10
ORTHO-PHOSPHATE (PO4-P)	0.05									
TOTAL PHOSPHATE (PO4)		0.06	0.18	0.49	0.18	0.09	0.03	1.64	0.02	0.09
CATION AND ANION BALANCE										
TOTAL CATIONS (MEQ/L)	7.044									
TOTAL ANIONS (MEQ/L)	7.125									
PERCENT DIFFERENCE	0.5									
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.320	0.33	0.23	0.21	0.06	0.17	0.22	1.25	0.22	0.22
BORON (B) TOTAL	0.095	0.090	0.151	0.080		0.060	0.140	0.161	0.670	0.120

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	007	007	007	007	007	007	007	007	007	007
SAMPLE DATE	10/12/83	06/21/84	08/09/84	10/11/84	06/13/85	08/14/85	10/22/85	06/02/86	08/13/86	10/09/86
TRACE ELEMENTS										
IRON (FE) TOTAL	3.390	0.06	3.04	2.06	0.66	0.31	1.84	29.60	0.38	0.52
IRON (FE) DISS	0.120	0.01	<0.01	0.03	0.04	<0.01	0.03	<0.01	<0.01	<0.01
MANGANESE (MN) TOTAL	0.210	0.01	0.07	0.07	0.14	<0.02	0.10	1.46	<0.01	0.04
MANGANESE (MN) DISS	0.010	0.01		0.03	0.13	<0.02	0.03	<0.01	<0.01	<0.01

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	042	042	042	042	042	042	042	045A	046	046
SAMPLE DATE	06/12/85	08/13/85	10/08/85	06/04/86	08/12/86	10/08/86	06/16/87	06/03/78	09/26/78	07/03/79
LOCATION	22S05E	22S05E	22S05E	22S05E	22S05E	22S05E	22S05E		22S04E	22S04E
LOCATION	16DAD	16DAD	16DAD	16DAD	16DAD	16DAD	16DAD		12CDB	16CDB
DESCRIPTION	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	N FORK QUIT	QUIT CK	CONVULSION	CONVULSION
DESCRIPTION	CK NR MOUTH	CK NR MOUTH	CK NR MOUTH	CK NR MOUTH	CK NR MOUTH	CK NR MOUTH	CK NR MOUTH	BLW DRNFLD	CANYON	CANYON
REMARKS	1400 HRS	1600 HRS	1500 HRS	1330 HRS	1400 HRS	1450 HRS	1315 HRS			
PHYSICAL PARAMETERS										
FLOW (GPM)	4066	969	1149	3061	691	1032	1670		8.4	4.5
WATER TEMPERATURE (C)	20	22	6	17	19	15.5	20	15	8.5	19
SPEC. COND. (UMHOS/CM) FIELD	545	832	786	506	703	737	645	896	945	1000
SPEC. COND. (UMHOS/CM) LAB	1340	674	832	524	900	797	653	900	845	1000
PH FIELD	7.3	7.8	7.9	7.8	7.2	7.5	8.1	8.2	8.2	
PH LAB	7.50	8.35	7.95	8.40	8.30	8.10	8.00			
TURBIDITY (NTU) FIELD	100+	16	35							
TURBIDITY (NTU) LAB	0.65	32.90	34.00	1155	29.03	31.67	205.0			
TOTAL SUSP. SOLIDS								5		95
TOTAL DISS. SOLIDS MEAS.	868	440	630	328	580	518	444	580	549	652
COMMON IONS										
TOTAL HARDNESS AS CACO3	644	274	347	244	272	318	290			
CALCIUM (CA)	132.00	48.00	101.20	60.80	49.60	64.00	78.40	76.8	75.2	96.0
MAGNESIUM (MG)	75.40	36.96	22.80	22.10	35.50	37.90	22.50	60.9	60.5	74.4
SODIUM (NA)	86.00	59.00	38.00	25.35	38.48	46.20	36.04	47.0	40.0	34.4
POTASSIUM (K)	8.80	7.30						3.34	5.03	4.3
ACIDITY AS CACO3	21.40	10.70	24.00	<0.01	2.50	1.20	2.00			
ALKALINITY AS CACO3 (LAB)	346	188	239	200	184	208	193			
BICARBONATE (HCO3) (LAB)	442.0	229.4	292.0	220.0	195.2	205.0	239	376	456	503
CARBONATE AS CO3 (LAB)	<0.01	<0.01	<0.01		14.40	24.00	<0.01	<0.01	<0.01	<0.01
HYDROXIDE (OH)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			
SULFATE (SO4)	269	155	199	97	317	199	136	172	110	157
CHLORIDE (CL)	96.5	22.2	26.0	11.8	35.2	20.3	12.4	40	26	34
FLUORIDE (F)								0.19	0.23	0.26
NUTRIENTS										
NITRATE (NO3-N)	0.30	0.05	0.48	0.10	0.10	0.05	0.19			0.10
NITRATE + NITRITE AS N								0.03	0.03	
KJELDAHL NITROGEN AS N								0.14	<0.10	0.25
ORTHO-PHOSPHATE (PO4-P)								0.026	0.024	0.100
TOTAL PHOSPHATE (PO4)	0.08	<0.01	0.05	0.10	0.02	0.13	<0.04			
TRACE ELEMENTS										
ARSENIC (AS) TOTAL								<0.001	<0.001	<0.001
BARIUM (BA) TOTAL	0.06	0.06	0.30	0.53	0.08	0.09	0.11			
BORON (B) TOTAL		0.280	0.300	0.153	1.040	0.240	0.230			
CADMIUM (CD) TOTAL								<0.001	<0.001	<0.001

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	042	042	042	042	042	042	042	045A	046	046
SAMPLE DATE	06/12/85	08/13/85	10/08/85	06/04/86	08/12/86	10/08/86	06/16/87	06/03/78	09/26/78	07/03/79
TRACE ELEMENTS										
IRON (FE) TOTAL	0.09	0.07	0.70	10.80	0.85	0.24	2.76	0.121	0.111	1.230
IRON (FE) DISS	0.04	<0.01	0.02	<0.01	<0.01	<0.01	<0.01			
MANGANESE (MN) TOTAL	<0.01	<0.02	0.03	0.64	0.04	<0.01	0.10	0.033	0.101	0.181
MANGANESE (MN) DISS	0.03	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01			
SELENIUM (SE) TOTAL								<0.001	<0.001	<0.001
ZINC (ZN) TOTAL									0.017	
OTHER PARAMETERS										
SILICA (SIO2)								10.5		5.1

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003
SAMPLE DATE	10/12/83	10/28/83	11/14/83	06/20/84	08/08/84	10/10/84	06/13/85	08/14/85	10/22/85	06/05/86
DESCRIPTION	MINE	MINE	MINE	MINE	MINE	MINE	MINE	MINE	MINE	MINE
DESCRIPTION	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT
REMARKS	1230 HRS	1300 HRS	1345 HRS	1450 HRS	1000 HRS	1235 HRS	1300 HRS	1430 HRS	1300 HRS	0900 HRS
PHYSICAL PARAMETERS										
WATER TEMPERATURE (C)	10			11	10					11
SPEC. COND. (UMHOS/CM) FIELD	890			954	879	809	894	1015	778	822
SPEC. COND. (UMHOS/CM) LAB	910			890	650	540	910	880	792	860
TURBIDITY (JTU) FIELD	9.1									
PH FIELD	6.3			7.0	7.2	6.6	6.4	6.7	6.5	7.1
PH LAB	7.20	7.30	7.10	7.30	7.40	7.90	7.35	7.25	7.40	7.60
TURBIDITY (NTU) FIELD				7.0	7.8	4.7	4.8	2.2	2.9	
TURBIDITY (NTU) LAB	0.95			1.00	2.60	2.50	0.93	0.50	0.19	0.48
TOTAL SUSP. SOLIDS		6.0	12.0		4.0	2.0	2.0	4.0	3.0	6.0
TOTAL DISS. SOLIDS MEAS.	599	660	620	570	420	350	592	576	570	570
COMMON IONS										
TOTAL HARDNESS AS CACO3	428			420	415	305	430	410	444	384
CALCIUM (CA)	92.00			89.60	96.00	59.00	102.40	94.40	104.00	
MAGNESIUM (MG)	47.52			51.84	42.00	38.00	42.00	41.80	44.20	38.90
SODIUM (NA)	40.00			33.90	34.10	30.40	56.00	60.00	35.00	148.40
POTASSIUM (K)	2.9			2.6			5.50	5.30		
ACIDITY AS CACO3	22.00	28.00	42.00	44.00	9.00	12.00	14.50	17.50	22.90	2.40
ALKALINITY AS CACO3 (LAB)	250	246	250	264	310	250	254	258	260	257
BICARBONATE (HCO3) (LAB)	305.00			322.1	378.2	305.0	305.0	314.8	317.2	350.0
CARBONATE AS CO3 (LAB)	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
HYDROXIDE (OH)	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SULFATE (SO4)	240			218	237	40	223	199	205	246
CHLORIDE (CL)	14.00			13.0	11.0	26.0	14.0	15.6	10.9	
NUTRIENTS										
NITRATE (NO3-N)	0.04			<0.01	0.10	1.16	0.01	0.05	0.14	1.04
ORTHO-PHOSPHATE (PO4-P)	0.35									
TOTAL PHOSPHATE (PO4)				0.50	0.10	0.15	0.02	0.02	<0.01	0.01
CATION AND ANION BALANCE										
TOTAL CATIONS (MEQ/L)	10.315									
TOTAL ANIONS (MEQ/L)	10.395									
PERCENT DIFFERENCE	0.3									
TRACE ELEMENTS										
BARIUM (BA) TOTAL	0.079			0.07	0.05	0.05	0.04	0.04	0.06	0.05
BORON (B) TOTAL	0.050			0.065	0.552	0.390	0.020	0.360	0.350	0.513
IRON (FE) TOTAL	0.110	0.050	0.115	0.18	0.12	0.18	0.02	<0.01	0.05	0.62
IRON (FE) DISS	0.020			0.05	0.10	0.01	<0.01	<0.01	0.09	<0.01

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUMMARY OF WATER QUALITY ANALYSES - SOUTHERN UTAH FUEL CO.

SITE NAME	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003	NPDES 003
SAMPLE DATE	10/12/83	10/28/83	11/14/83	06/20/84	08/08/84	10/10/84	06/13/85	08/14/85	10/22/85	06/05/86
TRACE ELEMENTS										
MANGANESE (MN) TOTAL	0.010			0.01	0.01	0.01	<0.01	<0.01	0.02	0.05
MANGANESE (MN) DISS	0.010			0.01	<0.01	0.01	<0.01	<0.01	0.02	<0.01
OTHER PARAMETERS										
OIL AND GREASE			<0.2		1.2		0.6	0.8	0.2	<0.1

All quantities in milligrams per liter unless otherwise noted. Blank line indicates parameter not tested.

Output Date: 09-11-1987
HWQ-6/86-R1

SUBSIDING ESCARPMENTS

A REPORT ON AN EXPERIMENTAL PRACTICE

by

Dall Dimick

SOUTHERN UTAH FUEL COMPANY

September 1991

SUBSIDING ESCARPMENTS

A REPORT ON AN EXPERIMENTAL PRACTICE

ABSTRACT

The Division of Oil, Gas and Mining granted Southern Utah Fuel Company conditional approval to undermine a test section of escarpment. The objective was to ascertain whether or not the escarpment could be undermined by longwall while causing minimal surface damage.

The escarpment test area was monitored visually, by photography and reliable survey measurements were made of horizontal and vertical movement. Monitoring stations were installed in high and low tension areas around the escarpment and near eroded blocks which were standing independent of the cliff face. One of the independent blocks fell during subsidence and a few tension cracks were created along the cliff face. No other visible signs of mining were found even though the surface elevations were reduced several feet. Monitoring stations moved horizontally from a few tenths of a foot to nearly three feet. Most of the movement was oriented parallel to the longwall face with indications that the natural jointing pattern and the slope of the terrain also influenced movement direction. Subsidence occurred in a predictable manner varying from one foot to seven feet with minimal surface damage.

SUBSIDING ESCARPMENTS

INTRODUCTION

Because of environmental concerns, the current policy regarding coal mining beneath escarpments is to protect the escarpments in their entirety. To accomplish this, any undermining must be severely limited or prohibited which influences a large percentage of the recoverable coal reserves. Since the goal of the mining industry and Federal agencies alike is to maximize reserve recovery while minimizing surface damage, a joint Southern Utah Fuel Company - Regulatory Authority effort is being made to study a section of undermined escarpment; the objective being to ascertain whether or not an escarpment can be undermined by a longwall with minimal or no surface damage.

The test section under study is located on the Wasatch Plateau on the west side of Quitchupah Canyon. It is within a Federal coal lease held by Southern Utah Fuel Company (SUFCo). The location of the study area is shown on Dwg. No. 1.

Southern Utah Fuel Company has been retreat mining using room and pillar methods for 14 years. Nearly 11,000 acres have been mined with good success. The surface above these areas subsided in a predictable manner with maximum subsidence varying from 4.5 ft. to 8.0 ft. Included in this subsided

area is about 7,000 linear ft. of escarpment which was affected by the room and pillar method.

Two thousand feet of escarpment was undermined on the east side of Quitchupah Canyon on Fee property and 5,000 ft. around the head of East Spring Canyon on a Federal lease. The East Spring Canyon escarpment is not as dramatic as that of Quitchupah Canyon, but the cliff-forming sandstone member, the Castlegate Sandstone, is the same in both areas. The main difference is that there is more strata exposed below the cliffs of Quitchupah Canyon because it is deeper than East Spring Canyon.

In the East Spring Canyon area, many tension cracks were found around the perimeter of the canyon. Most of these were natural joints which were temporarily amplified by subsidence. There were no slope or cliff failures along the entire 5000 ft. of affected escarpment.

On the 2000 ft. of fee area escarpment in Quitchupah Canyon, the same pattern of cracking occurred above three room and pillar panels as at the East Spring Canyon site. There were no slope failures, but one incidence of cliff spalling occurred. An "across the canyon view" of this spall is shown in Photo 1 on Plate 1.

SUFCo implemented a longwall mining system in 1985. The first three panels were mined during 1985, 1986, and 1987 under the

plateau and little Duncan Mountain where there were no canyon escarpments. There was a noticeable difference in the formation of tension cracks between longwall and room and pillar mining methods. Surface tension cracks were usually created in all the room and pillar blocks - especially above the corners of the excavation. However, the surface areas above the first longwall blocks were void of any visible tension cracks.

Because of the past experience with room and pillar mining beneath escarpments and the absence of tension cracks in the first longwall panels, there appeared to be a possibility that resource recovery could be maximized by undermining escarpments with a longwall. Therefore; SUFCo pursued making a modification to the approved subsidence zone to include a test section of Quitchupah Canyon escarpment under the "Experimental" provisions of SMCRA regulations.

The experimental project began with a letter from SUFCo to the Division of Oil, Gas and Mining (DOGM) in June, 1986 requesting a modification to the current subsidence zone. At that time there were no Quitchupah escarpment areas included in the planned subsidence zone. The modification was to add a section of escarpment (on the west side of Quitchupah Canyon) to the approved subsidence area. It was proposed that three longwall panels be mined in the vicinity of the escarpment. The north end of two of the panels were designed to extend beyond the

escarpment out under the canyon. The third panel was located entirely beyond the cliff and under the canyon wall.

DOGM corresponded with other regulatory agencies for comments and eventually granted a conditional approval to undermine a test section of escarpment. The conditions required that:

1) SUFCo make a detailed raptor survey of all cliffs on both the east and west sides of Quitchupah Canyon,
2) SUFCo provide detailed subsidence monitoring of the undermined escarpment.

SUFCo completed the raptor survey by helicopter on April 14, 1987 and drafted an approved subsidence monitoring plan which was implemented in June, 1987.

PREMINING VISUAL SURVEY

The monitoring program began with a visual survey of the entire test area. The cliff-forming part of the escarpment in this area is the castlegate sandstone which is approximately 150 ft. thick. As shown on Dwg. No. 2, the test section is made up of approximately equal lengths of north and east facing slopes. The entire area [like all Quitchupah Canyon escarpment] is heavily fractured by natural jointing and in some areas is highly sculpted where the combined effects of jointing and erosion are the most severe. The slopes are littered from top to bottom with blocks of stone which have eroded away from the castlegate and numerous other smaller sandstone members of the Blackhawk formation. Scars made from

natural spalling of the castlegate are visible on all slopes. One such natural scar is shown on Photo 2, Plate 1.

During the visual survey, locations were chosen for photo stations so that any visible subsidence effects could be recorded while performing horizontal and vertical movement surveys. Photos of the escarpment along the entire study area were taken prior to any under-mining. Duplicate photos with the same field of view were then taken during each horizontal-vertical movement survey. Photos showing the study area escarpment are included in Plates 2 to 6. With the exception of one area where a small spall occurred, there is no discernable difference in the interim photos. Therefore, only the pre-mining and post-mining set of photos are shown for comparison. Drawing No. 14 shows the general area each photo represents. This same area is also covered by periodic aerial Color Infrared photos which are furnished to the USFS as part of SUFCo's ongoing subsidence monitoring program.

MONITORING STATIONS

A total of eight monitoring stations were installed along the test escarpment. The locations are shown on Dwg. No. 2. Stations 2, 3, 4 and 5 were installed above panel centers and edges so that horizontal and vertical displacement measurements could be obtained in both high and low surface tension areas.

Stations 6 and 7 were placed next to cliff features which had a high potential for falling into the canyon. Station 8 was a fill-in station and 15 is a control station being used for the aerial subsidence determination program.

Locations for stations 6 and 7 were found during the premining visual survey. Number 6 was placed next to an independent "nose", or spire created by jointing and erosion where the escarpment changed direction by 90 degrees. Natural fractures cross this feature at 45 degrees, separating the "nose" from the main cliff by 2 ft. The feature at station 7 is a free-standing block of stone separated from the cliff face by natural jointing and erosion. This feature is shown in photos 5 and 6 on Plate 4 and 5.

TENSION CRACKS

After the monitoring stations were installed and under-mining began, periodic visual surveys were made to locate and catalog tension cracks.

During one such survey on November 5, 1987, tension cracks were discovered to the north and west of monitoring station No. 3. The orientation of all the cracks in this group were either parallel or perpendicular to the natural jointing pattern. Tension crack locations are shown on Dwg. No. 2.

Their gap severity ranged from hairline to about four inches in width with little or no vertical displacement. The panel beneath this set of cracks [Panel No. 1] had retreated approximately 750 ft. to the south southeast when the cracking occurred.

A second set of cracks located around monitoring stations 5 and 6 were discovered in early October 1988. One complete monitoring survey [including horizontal, vertical and photographic measurements] had been completed on July 14, 1988, finding no evidence of cracking. By the time these new cracks were discovered, all three panels in the study area had been completely mined. Panel 3 was finished in September 1988.

The orientation of three of the cracks in the second group is parallel to the natural jointing direction of N 26° W. The fourth tension crack, located just off the cliff edge to the east of Station 6, is located above and parallel to the un-mined gate road pillars between Panels 2 and 3. The gap severity of these cracks varied from about 2 inches to 6 inches. The only vertical displacement along cracks in the study area was noted on the crack between Station 4 and 5. Here the displacement varied up to 10 inches along approximately 150 linear feet of the crack.

From past measurements in other subsidence areas at SUFCo, it

has been determined that vertical displacement along surface tension cracks mainly occurs where the crack is associated with a natural fault. Also, where surface displacement occurs, the associated fault usually already has natural displacement. This is true with the tension crack between station 4 and 5. It is associated with a natural fault found to have 1.5 ft. displacement in the same direction as the surface crack.

All the cracks which were located in the study area had the most severe visual appearance when they were first formed. From that time on, they have been slowly closing. In fact, some which are shown on the maps are now hardly visible. This self-healing phenomena is not uncommon on the SUFCo property and has been well documented by Fishlake National Forest personnel.

A study was conducted in 1978 under the direction of a U.S. Forest Service Environmental Geologist, Jerome V. DeGraff. A report of this study was published with the title of "GEOLOGIC INVESTIGATION OF SUBSIDENCE TENSION CRACK "SELF-HEALING" PHENOMENA" under his name. The following is an excerpt from this report:

> "... Monitoring stations were installed along twenty-two different cracks widely distributed over the subsiding area. Weekly measurements were taken from mid-June to October. Cracks range in width from 6 inches to 1/8 inch.

Preliminary analysis confirms the "self-healing" activity. Several cracks closed to less than 1/16 inch. "Self-healing" rate averages slightly more than 1/16 inch per week of closure. Measured rates ranged from less than 1/32 inch to more than 1/4 inch per week. The average amount of crack closure is 56%...."

Horizontal Ground Movement

All of the monitoring stations in the study area were installed before any undermining began. They were then surveyed for horizontal movement periodically over a three year period. A graphic representation showing the deviation from the original positions is shown for each of the stations on drawings No. 3 to 11.

The graphs show that most of the total horizontal movement occurs rather rapidly and has been found to correspond with the major subsidence events. Horizontal movements of a few tenths of a foot to nearly 3 ft were measured in the study area. The direction of movement appears to be controlled by panel geometry, faulting and the slope of the terrain.

Horizontal movements due to subsidence are typically thought to be towards the center of the subsidence trough. As shown on the graphs, this condition is not always true. There is also a tendency for the surface to move downhill in sloping terrain.

A 1988 Bureau of Mines project titled "Subsidence Due to Undermining of Sloping Terrain: A Case Study" found this to be true. The resulting data shows that sloping terrain definitely alters the magnitude and direction of surface movement due to subsidence.

Some of the graphs showing movement in this study area show a possible down-hill influence on horizontal surface movement. However, the major force influencing movement direction appears to be controlled by panel geometry. Most of the greatest movements shown by the graph vectors are parallel to the short axis of the panels. These movements are also not always toward the center of the underlying panel. Here is where the sloping terrain may have an effect on the movement direction. A more extensive study with a larger array of monitoring stations would be necessary to determine how these forces interact. A small vector diagram illustrating the directions of the natural faulting, panel geometry and down-hill slope is included with each movement drawing.

The pattern of surface movement is not restricted to the escarpment area only. There are several other monitoring stations on the SUFCo property which show a similar pattern. One such monitoring station is included in the surface movement graphs for comparison. The monitoring station is named Little Duncan and is located over 2,000 ft. from the escarpment and

the study area. Its graph bears a great resemblance to those of the study area. The station is located on a mountain top with steeply sloping sides. The graph clearly shows that the greatest movement is still parallel with the short axis of the panel.

Surface movement influenced by slope and panel geometry has been discussed so far. The third factor controlling surface movement is natural faulting or jointing. The graphs show that there is some movement which is parallel and perpendicular to the faulting plane. In the study area, this influence is not too prominent except at station 6. Here there was considerable movement parallel to the faulting plane. Besides the graphs, the tension cracks show evidence of surface movement related to the faulting planes. As shown on drawing No. 2 most of the surface tension cracks are parallel or perpendicular to the natural faulting plane. Although some of the movement is not great, the cracks still display the fact that natural faulting is one of the factors controlling the magnitude and direction of surface movements.

Since this particular section of escarpment was being used for a study area, no attempt was made in trying to strategically locate the underlying panels. As it turned out, the east-facing sections of escarpment were in a position which had a very high damage potential. The cliff parallels the long axis

of the panel and is also near the edge of an underlying panel. This places the cliff face in a high horizontal stress zone. To make things worse, surface movement paralleling the short axis of the panel is directly perpendicular to the cliff face which makes the probability of spalling very great.

Conversely, the north facing section of escarpment is oriented so that it has the least probability of failure. The mining panels intercept the cliff with the short axis of the panel directly paralleling the cliff face. Since the greatest amounts of recorded horizontal movements are along this line, the chances of a spall were reduced.

After subsidence and surface movement had occurred, the only visible damage to the cliff face in either area were a few tension cracks. The general surface area remained unchanged except for a scar on the canyon slope where a free-standing block of stone toppled. This event occurred after longwall panel three was mined. The results of the fall are shown in the photos.

VERTICAL GROUND MOVEMENT

Vertical subsidence in the escarpment test area happened in a predictable manner. It began when the extraction length was about equal to the width and continued rapidly for about one year until approximately 90% of maximum subsidence was attained. The remaining 10% occurred slowly over the next few years.

Maximum vertical subsidence varied from 1 ft. to 7 ft. across the test area depending upon overburden thickness and location above the mining activity. The greatest amount of subsidence, as expected, was outside the escarpment on the canyon slope where the overburden is thinner.

Vertical displacement of the test area is shown on Drawing No. 12. The contours represent the subsidence as of September 1990. It was determined by photogrammetric methods as part of SUFCo's annual subsidence monitoring program.

The relationship of subsidence vs. time for each of the monitoring stations is shown on Drawing No. 13. This graph shows that from initial subsidence to about 90% of maximum, approximately one year elapses. During this time however, it appears that most of the subsidence probably occurs as a single sudden event. It also appears that most of the horizontal movement occurs with this same event.

Summary

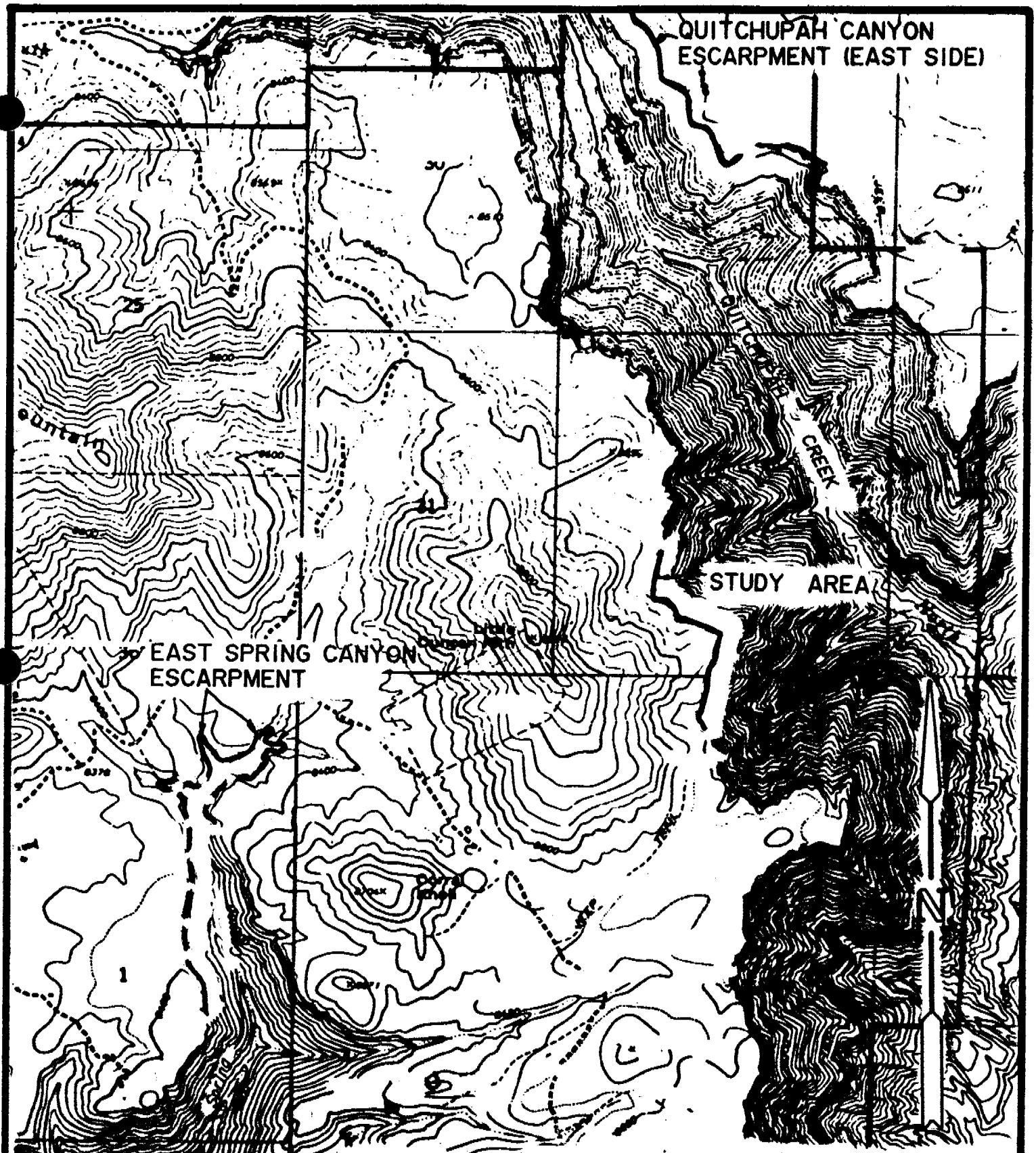
Southern Utah Fuel Company has been mining by room and pillar methods, causing surface subsidence, for more than 14 years. Included in this subsidence is approximately 7000 linear feet of escarpment. One cliff spall occurred in this section with no slope failures. SUFCo has been longwall mining since 1985

with a noticeable reduction of surface tension cracks as compared to room and pillar mining.

The Division of Oil, Gas and Mining granted Southern Utah Fuel Company conditional approval to undermine a test section of canyon escarpment using longwall mining methods. The objective was to ascertain whether or not the escarpment could be undermined by longwall while causing minimal surface damage.

The escarpment test area was monitored visually, by photography and with reliable survey measurements of horizontal and vertical movement. Monitoring stations were installed in high and low tension areas around the escarpment and near eroded blocks which were standing independent of the cliff face. One of the independent blocks fell during subsidence and a few tension cracks were created along the cliff face. No other visible signs of mining were found even though the surface elevations were reduced several feet. Monitoring stations moved horizontally from a few tenths of a foot to nearly three feet. Most of the movement was oriented parallel to the longwall face with indications that the natural jointing pattern and the slope of the terrain also influenced movement direction. Subsidence occurred in a predictable manner varying from one foot to seven feet with minimal surface damage.

doc#370

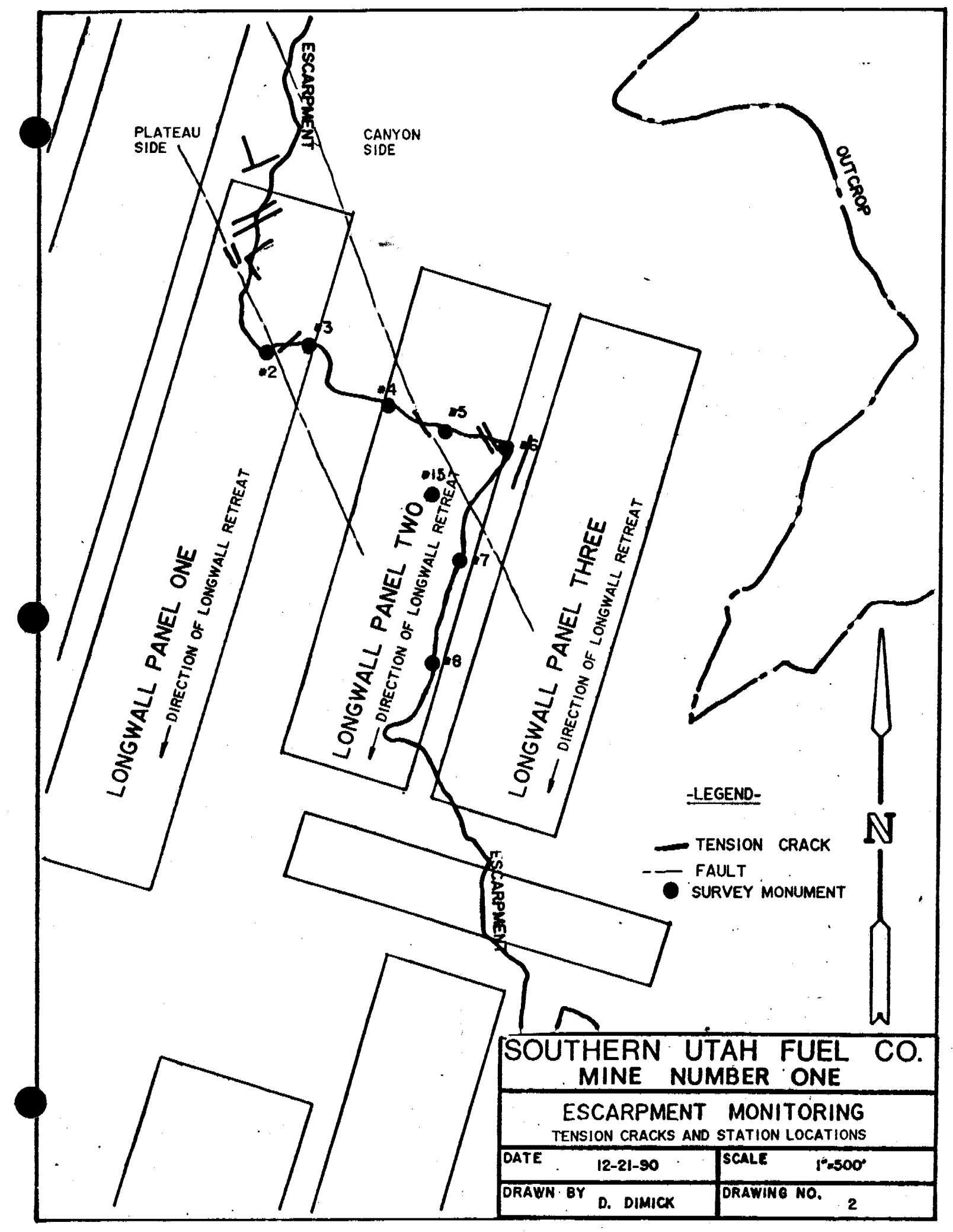


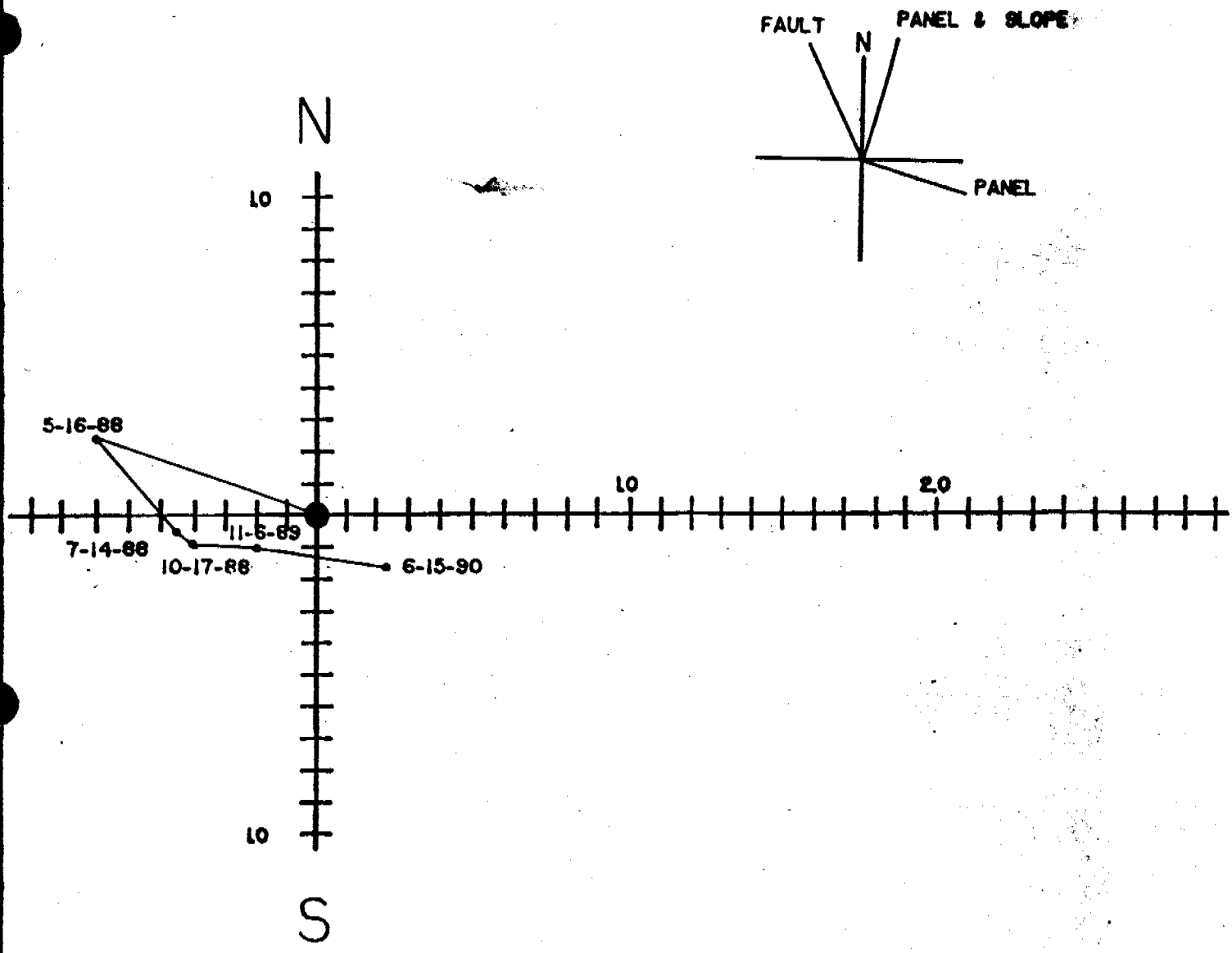
SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE

ESCARPMENT MONITORING

GENERAL LOCATION MAP

DATE 2-7-91	SCALE 1" = 2000'
DRAWN BY K. WALKER	DRAWING NO. 1


ESCARPMENT
PLATEAU SIDE
CANYON SIDE
OUTCROP
#2
#3
#4
#5
#6
#15
#7
#8
LONGWALL PANEL ONE
DIRECTION OF LONGWALL RETREAT
LONGWALL PANEL TWO
DIRECTION OF LONGWALL RETREAT
LONGWALL PANEL THREE
DIRECTION OF LONGWALL RETREAT
ESCARPMENT
-LEGEND-
TENSION CRACK
FAULT
SURVEY MONUMENT
N
SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE
ESCARPMENT MONITORING
TENSION CRACKS AND STATION LOCATIONS
DATE 12-21-90
SCALE 1"=500'
DRAWN BY D. DIMICK
DRAWING NO. 2



SURVEY MONUMENT

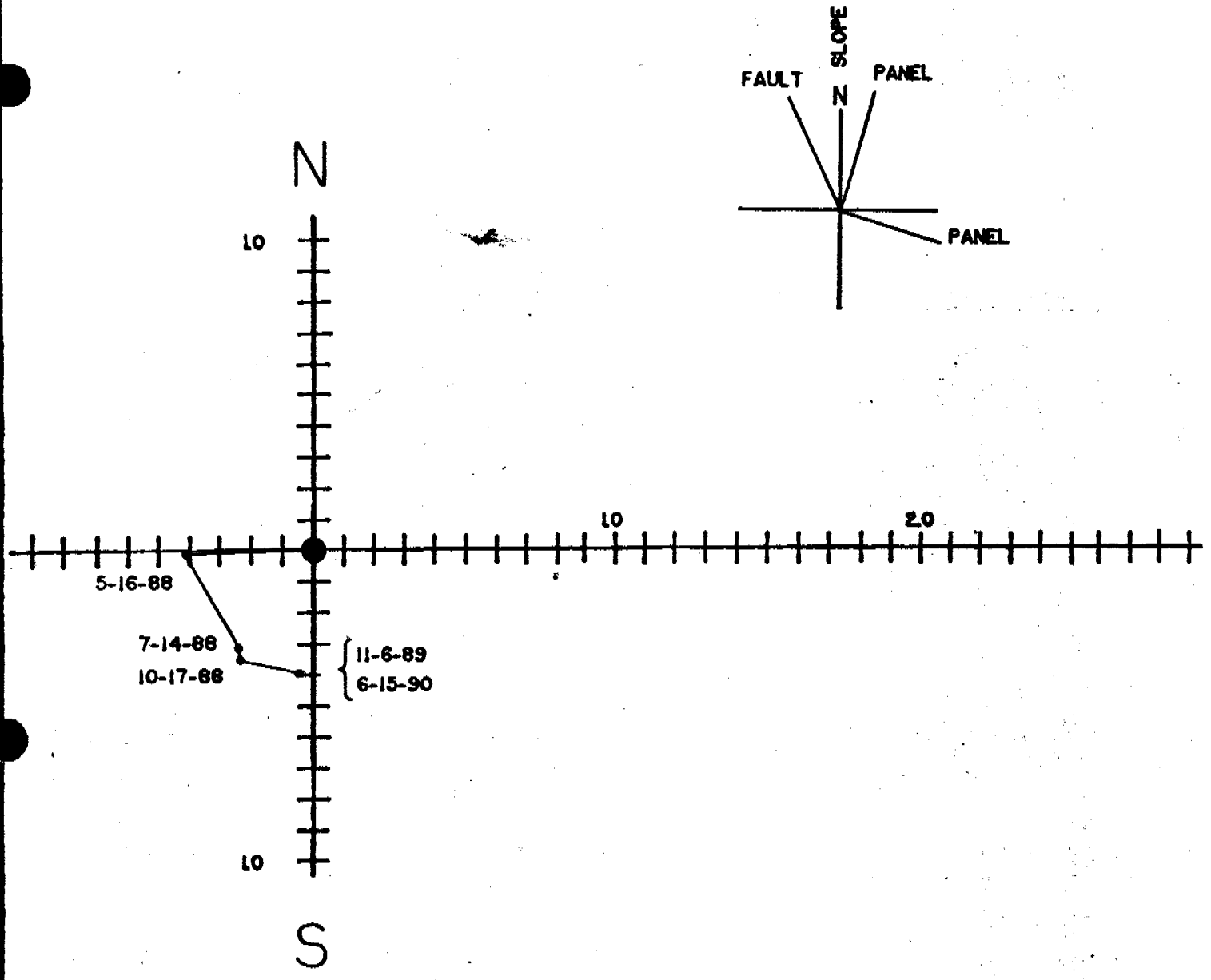
NO. 2

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE

ESCARPMENT MONITORING
- HORIZONTAL MOVEMENT

DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 3

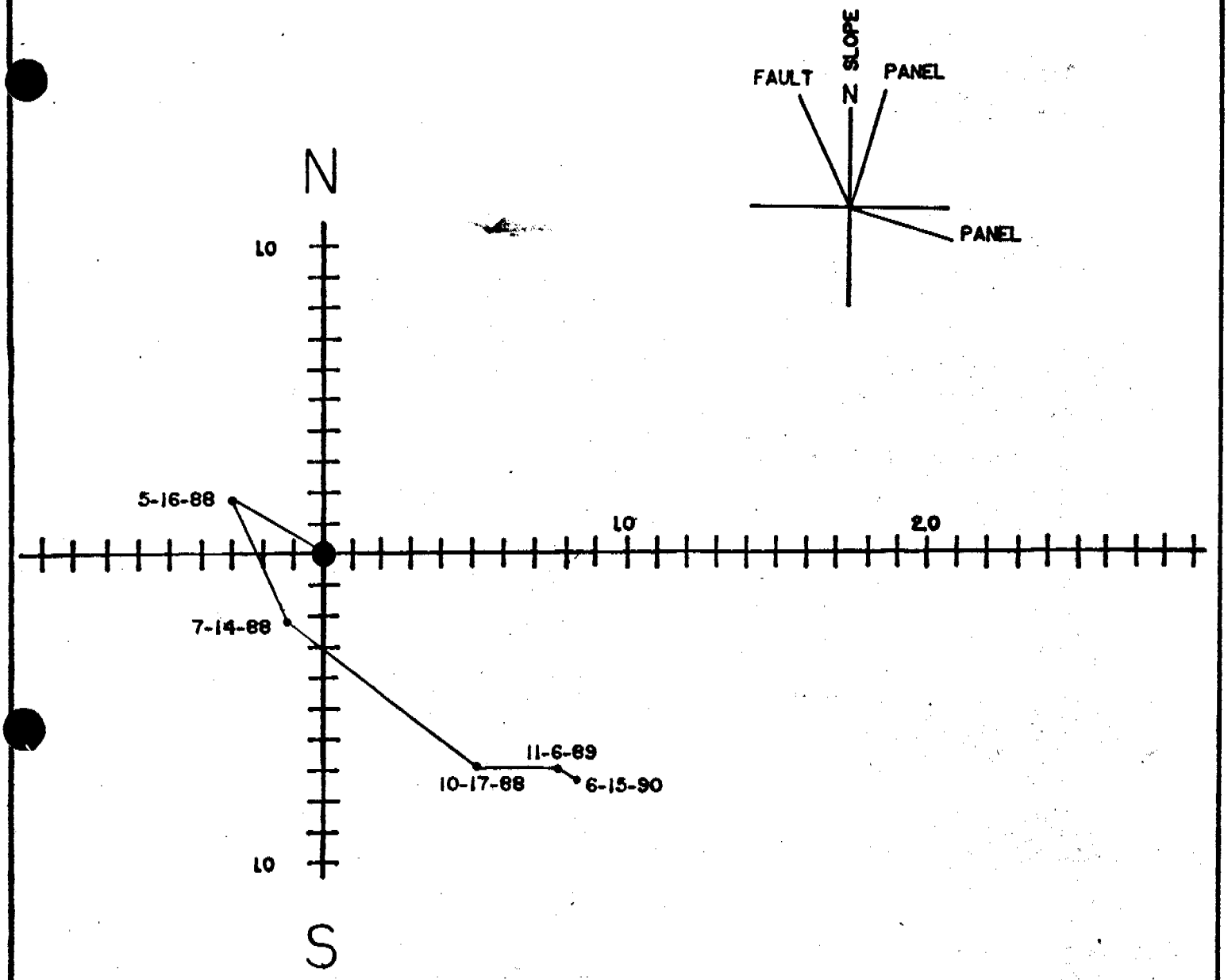


SURVEY MONUMENT

NO. 3

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 4



SURVEY MONUMENT

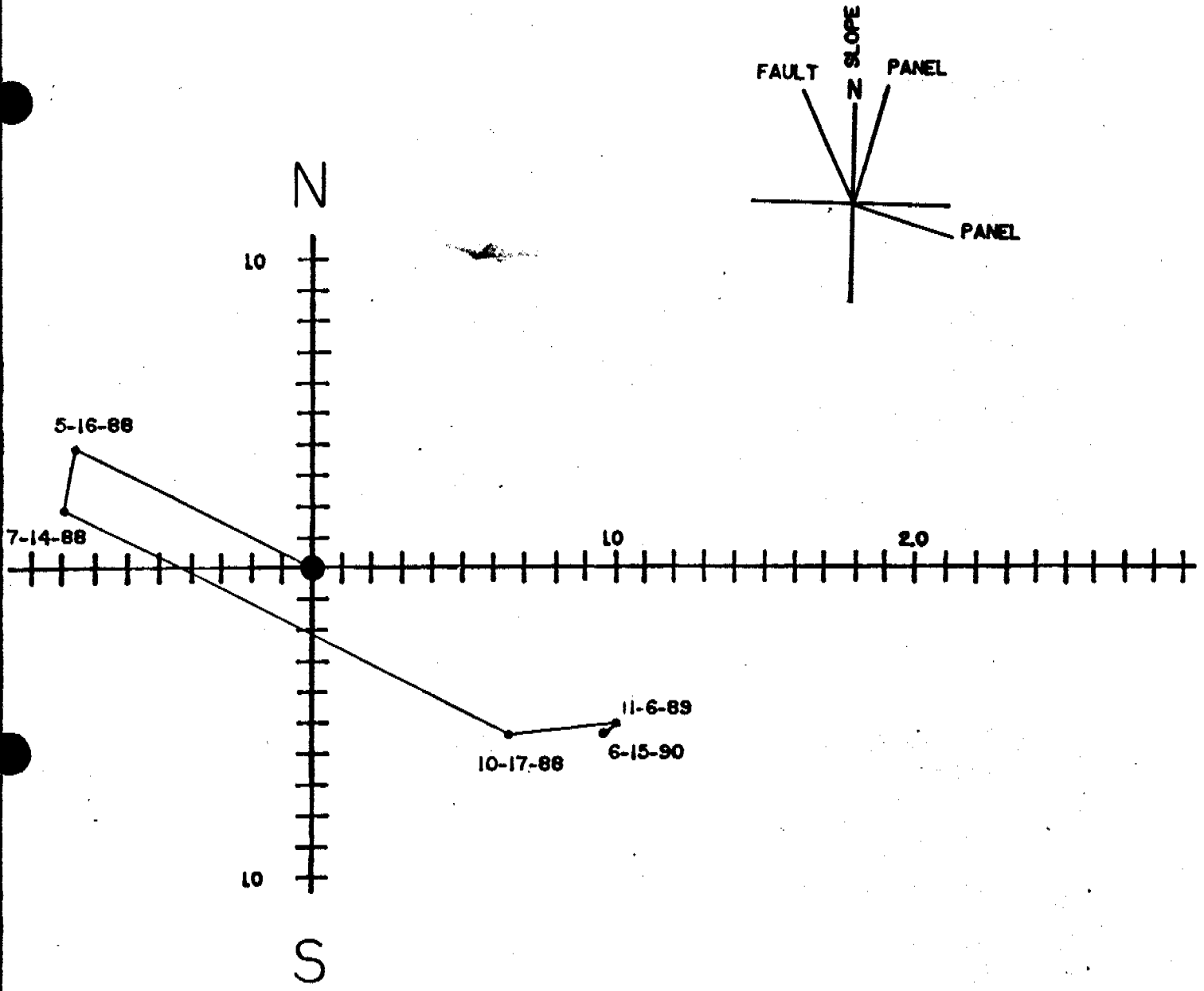
NO. 4

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE

ESCARPMENT MONITORING
HORIZONTAL MOVEMENT

DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 5

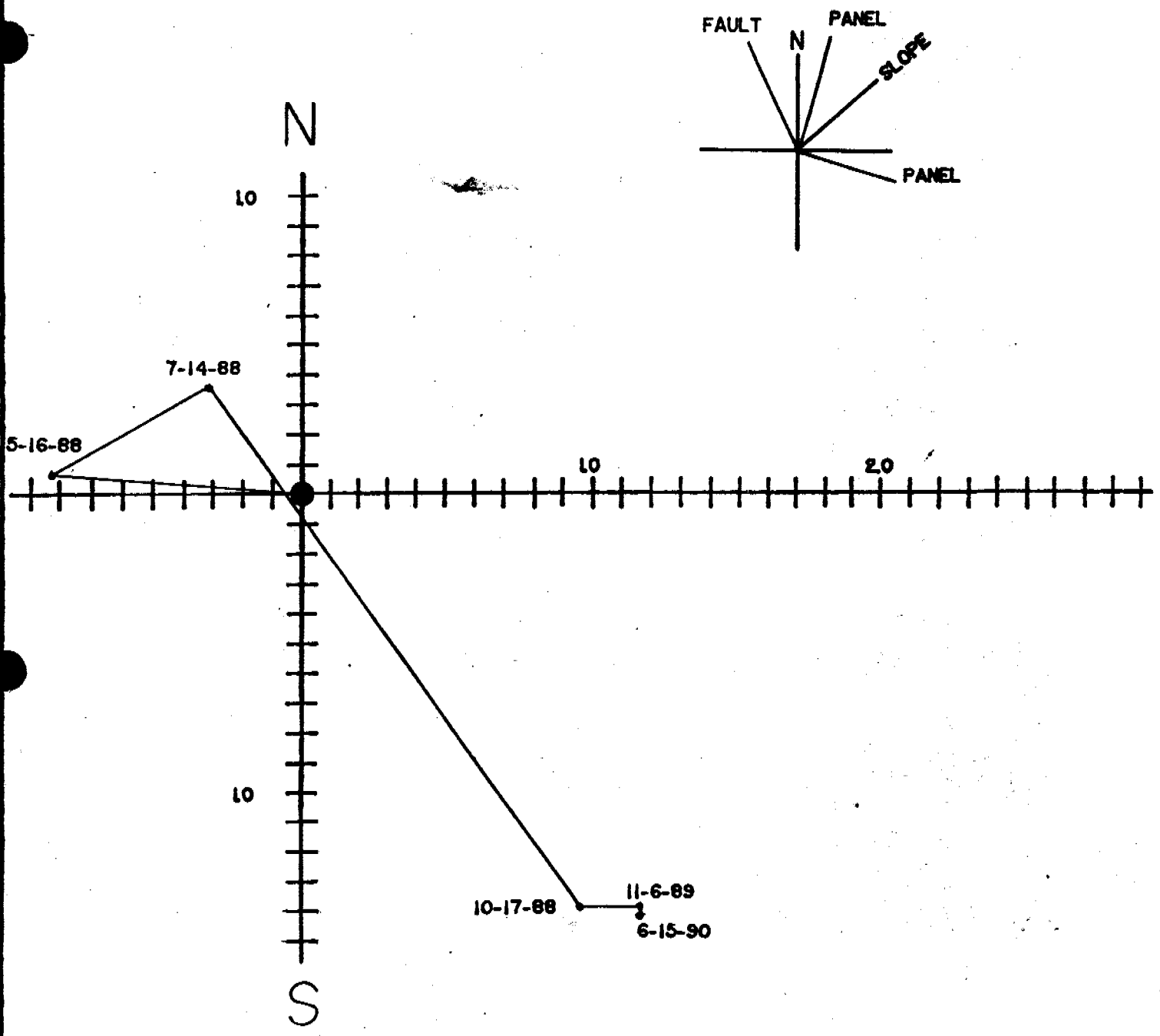


SURVEY MONUMENT

NO. 5

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 6

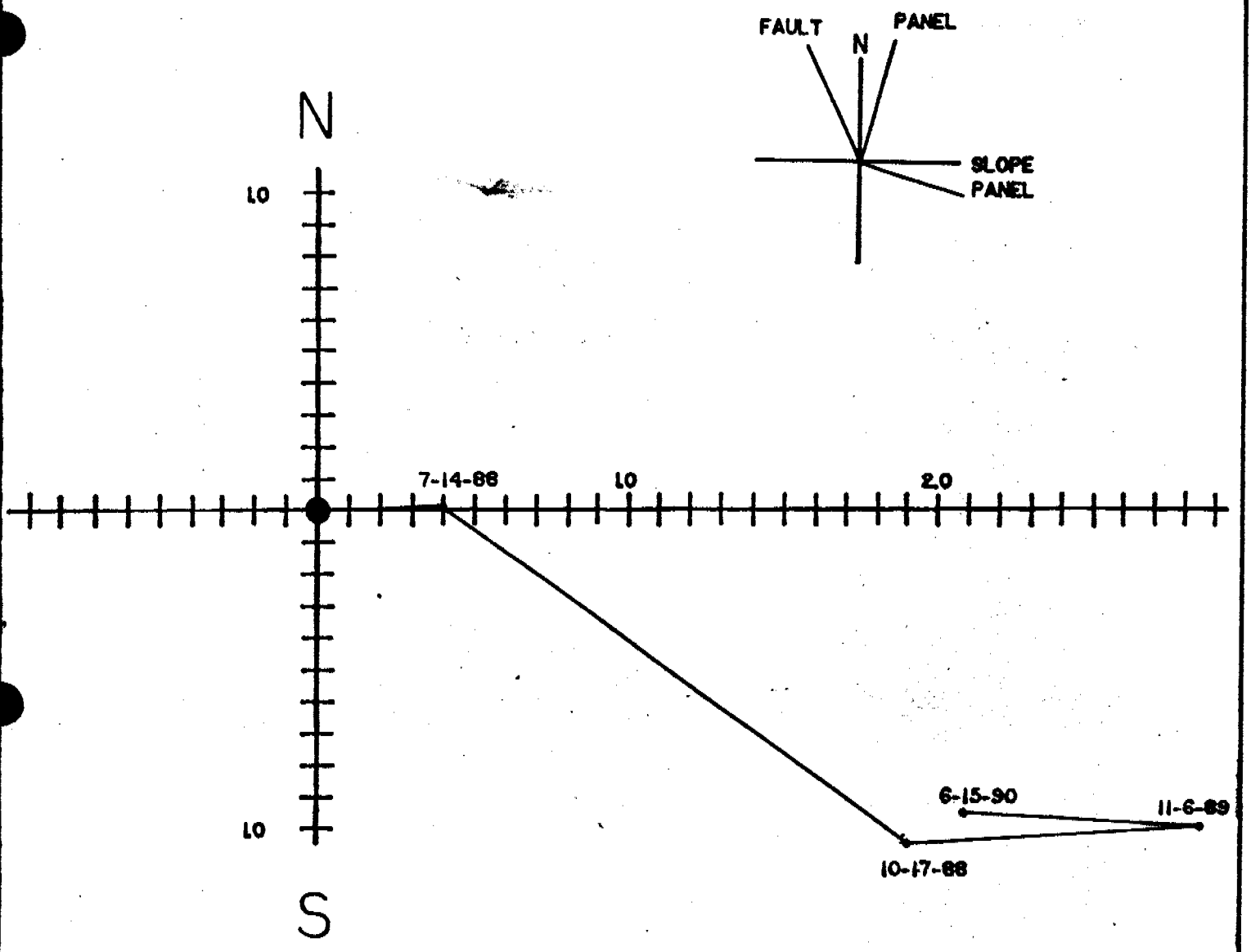


SURVEY MONUMENT

NO. 6

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 7

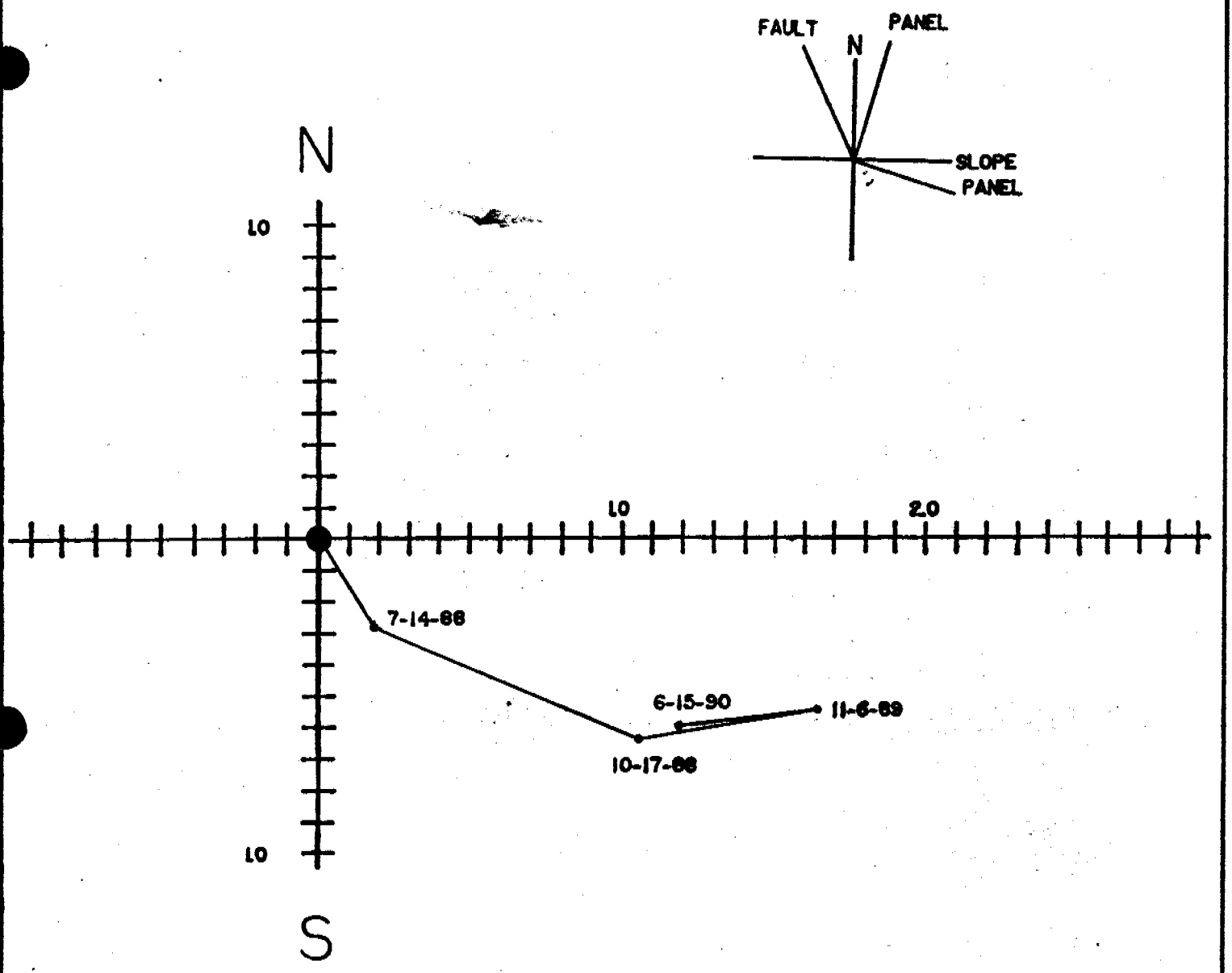


SURVEY MONUMENT

NO. 7

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 8

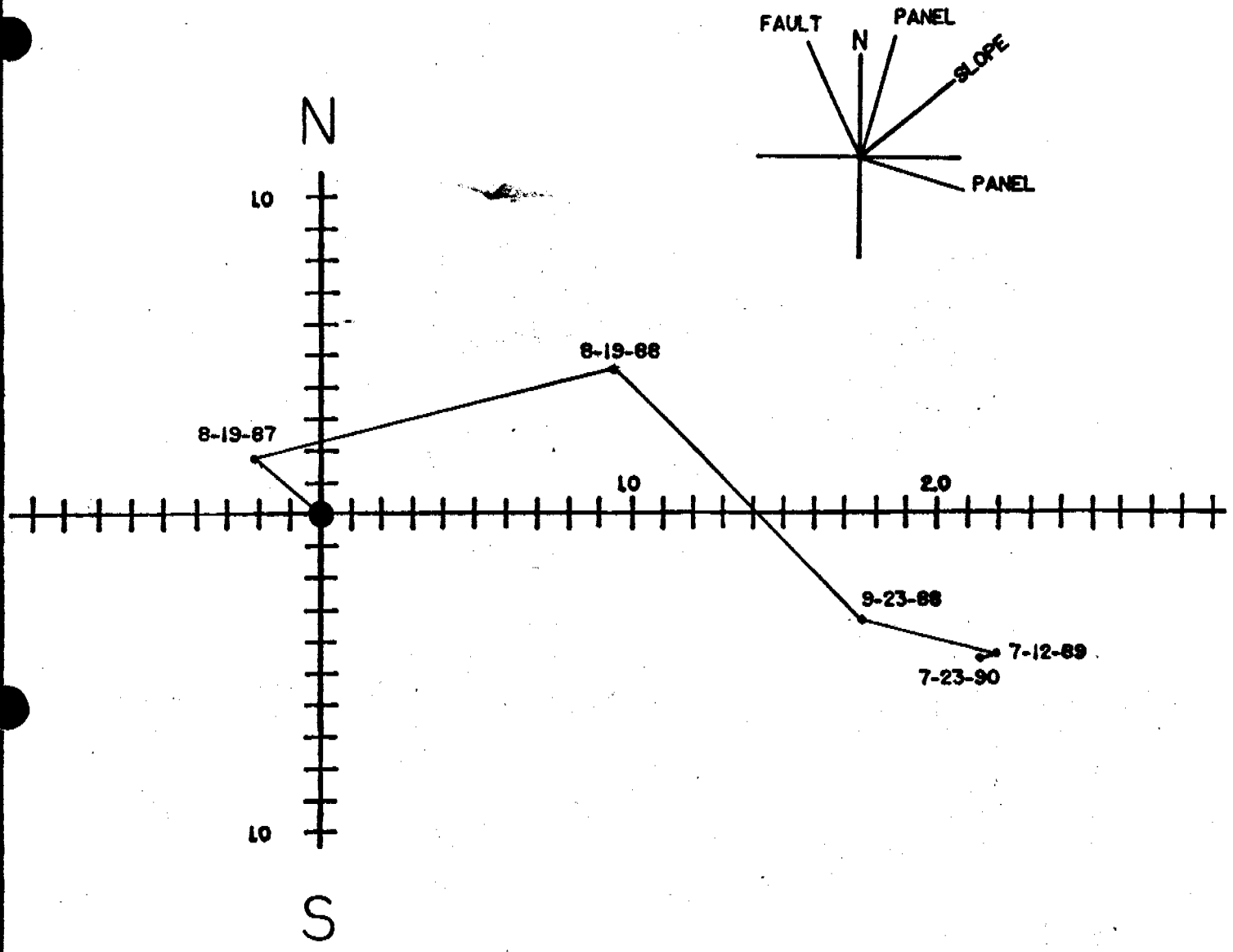


SURVEY MONUMENT

NO. 8

ORIGINAL MONUMENT
LOCATION
7-6-'87

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 9

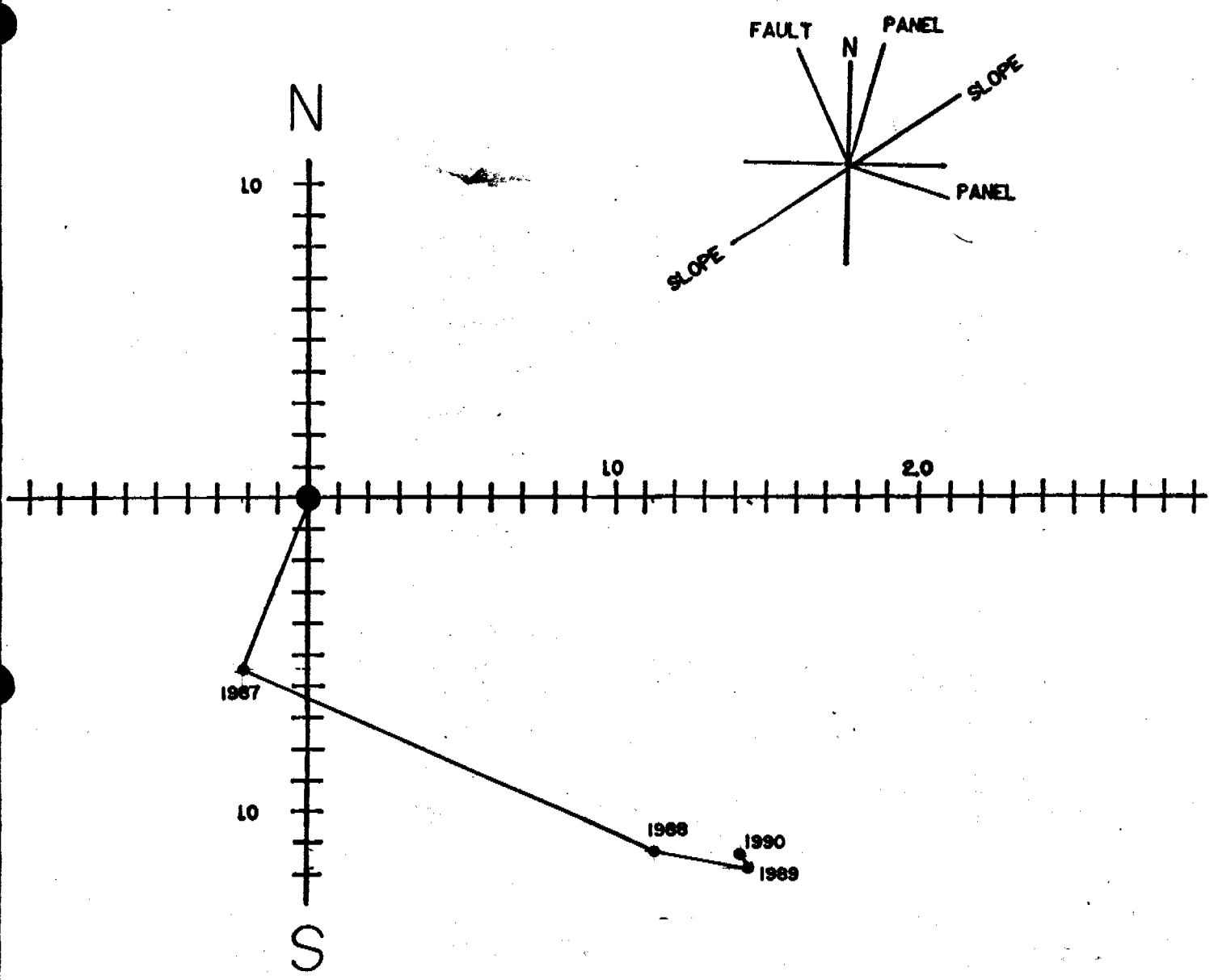


SURVEY MONUMENT

NO. 15

ORIGINAL MONUMENT LOCATION 8-26-86

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 10

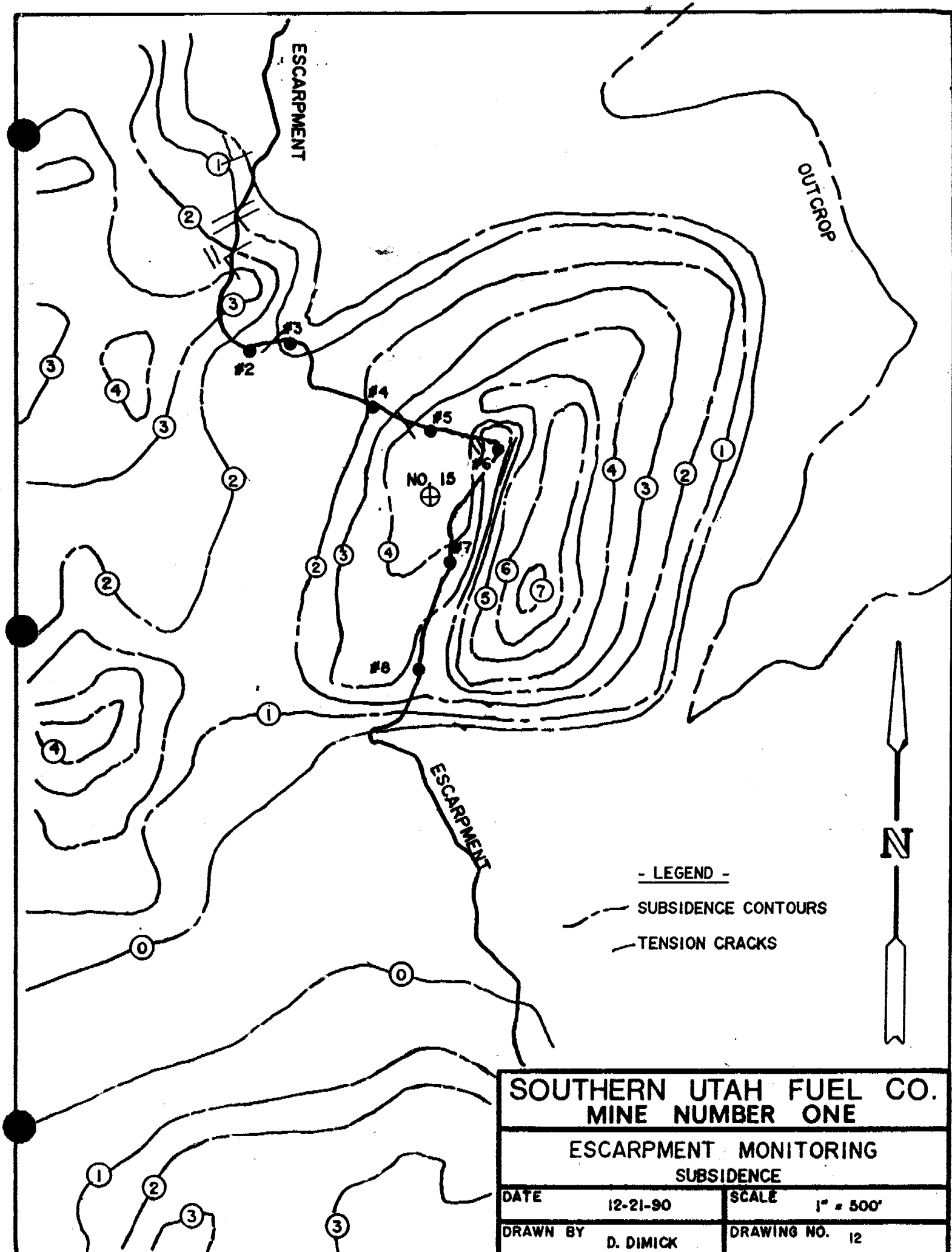


SURVEY MONUMENT

LITTLE DUNCAN

ORIGINAL MONUMENT LOCATION 1985

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING HORIZONTAL MOVEMENT	
DATE 12-21-'90	SCALE 1" = 0.5'
DRAWN BY D. DIMICK	DRAWING NO. 11



SOUTHERN UTAH FUEL CO.
MINE NUMBER ONE

ESCARPMENT MONITORING
SUBSIDENCE

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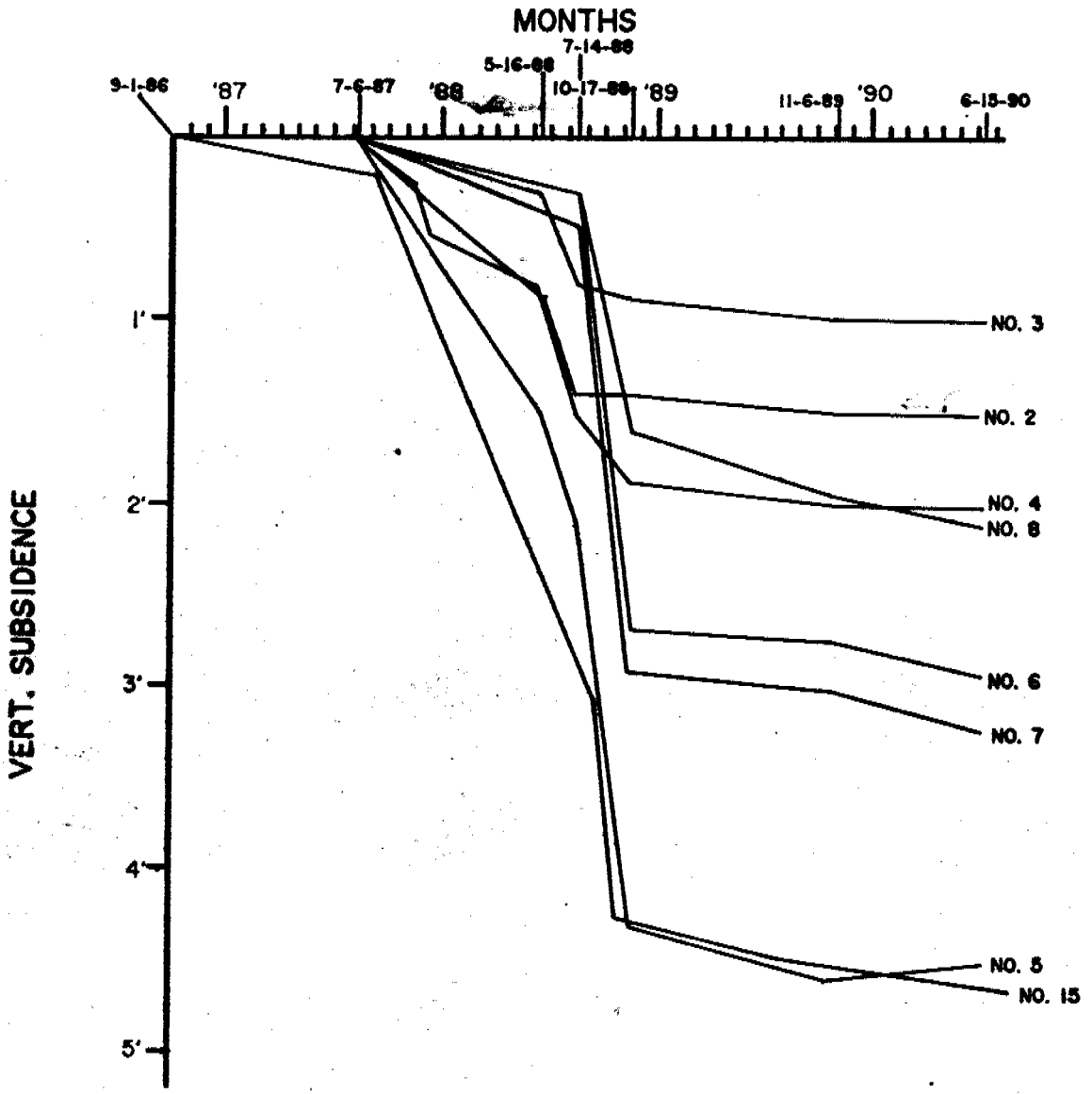

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ESCARPMENT MONITORING SUBSIDENCE VS. TIME	
DATE 12-21-90	SCALE
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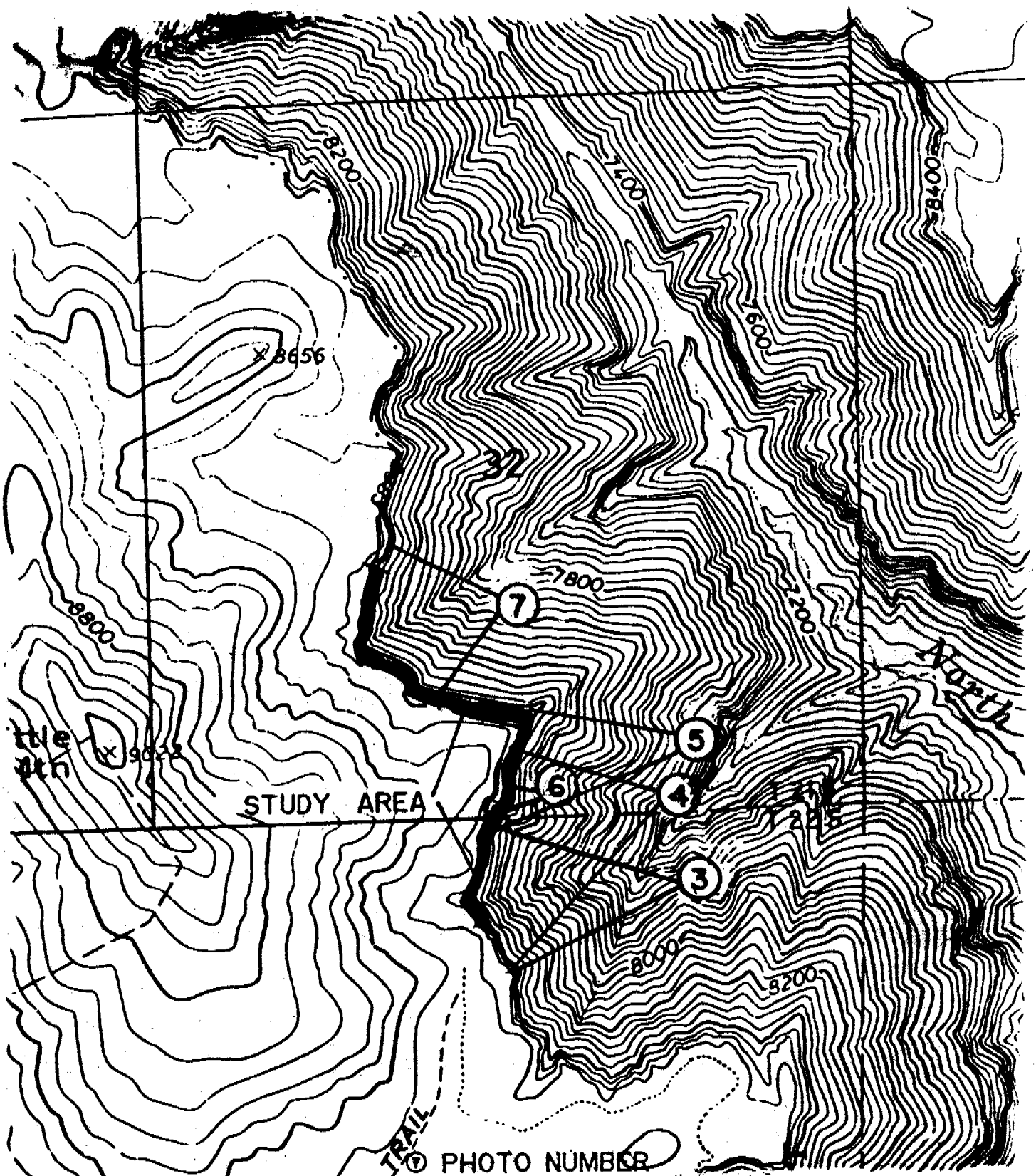

SOUTHERN UTAH FUEL CO. MINE NUMBER ONE	
ESCARPMENT MONITORING PHOTO LOCATIONS	
DATE	SCALE 1"=1,000'
DRAWN BY	DRAWING NO.

APPLICATION FOR PERMIT CHANGE

Title of Change:	Permit Number: ACT / 041 / 002
Exploration Drilling	Mine: SUFCo Mine
	Permittee: Coastal States Energy Co.

Description, include reason for change and timing required to implement:

This permit change addresses exploration drilling and related activities which were not addressed in the recent M&RP. The permit change must be approved by April 1994.

☐ Yes	X No	1. Change in the size of the Permit Area? _____ acres ☐ increase ☐ decrease.
X Yes	☐ No	2. Change in the size of the Disturbed Area? 6.3 acres X increase ☐ decrease.
☐ Yes	X No	3. Will permit change include operations outside the Cumulative Hydrologic Impact Area?
☐ Yes	X No	4. Will permit change include operations in hydrologic basins other than currently approved?
☐ Yes	X No	5. Does permit change result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes	X No	6. Does permit change require or include public notice publication?
☐ Yes	X No	7. Permit change as a result of a Violation? Violation #
☐ Yes	X No	8. Permit change as a result of a Division Order? D.O.#
☐ Yes	X No	9. Permit change as a result of other laws or regulations? Explain:
☐ Yes	X No	10. Does permit change require or include ownership, control, right-of-entry, or compliance information?
X Yes	☐ No	11. Does the permit change affect the surface landowner or change the post mining land use?
☐ Yes	X No	12. Does permit change require or include collection and reporting of any baseline information?
X Yes	☐ No	13. Could the permit change have any effect on wildlife or vegetation outside the current disturbed area?
X Yes	☐ No	14. Does permit change require or include soil removal, storage or placement?
X Yes	☐ No	15. Does permit change require or include vegetation monitoring, removal or revegetation activities?
☐ Yes	X No	16. Does permit change require or include construction, modification, or removal of surface facilities?
X Yes	☐ No	17. Does permit change require or include water monitoring, sediment or drainage control measures?
☐ Yes	X No	18. Does permit change require or include certified designs, maps, or calculations?
☐ Yes	X No	19. Does permit change require or include underground design or mine sequence and timing?
☐ Yes	X No	20. Does permit change require or include subsidence control or monitoring?
☐ Yes	X No	21. Have reclamation costs for bonding been provided or revised for any change in the reclamation plan?
X Yes	☐ No	22. Is permit change within 100 feet of a public road or perennial stream or 500 feet of an occupied dwelling?
X Yes	☐ No	23. Is this permit change coal exploration activity X inside ☐ outside of the permit area?

X Attach 3 complete copies of proposed permit change as it would be incorporated into the Mining and Reclamation Plan.

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

_____

Signed - Name - Position - Date

Subscribed and sworn to before me this ____ day of _____, 19 ____.

_____

Notary Public

My Commission Expires: _____, 19____

Attest: STATE OF _____ } ss:

COUNTY OF _____ }

Received by Oil, Gas & Mining

93C

ASSIGNED PERMIT CHANGE NUMBER

APPLICATION FOR PERMIT CHANGE

Title of Change:	Permit Number: ACT / 041 / 002
Exploration Drilling	Mine: SUFCO
	Permittee: Coastal States Energy Co.

Description, include reason for change and timing required to implement:

This permit change addresses exploration drilling and related activities which were not addressed in the recent M&RP. The permit change must be approved by April 1994.

☐ Yes	X No	1. Change in the size of the Permit Area? _____ acres ☐ increase ☐ decrease.
X Yes	☐ No	2. Change in the size of the Disturbed Area? 2.92 acres X increase ☐ decrease.
☐ Yes	X No	3. Will permit change include operations outside the Cumulative Hydrologic Impact Area?
☐ Yes	X No	4. Will permit change include operations in hydrologic basins other than currently approved?
☐ Yes	X No	5. Does permit change result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes	X No	6. Does permit change require or include public notice publication?
☐ Yes	X No	7. Permit change as a result of a Violation? Violation #
☐ Yes	X No	8. Permit change as a result of a Division Order? D.O.#
☐ Yes	X No	9. Permit change as a result of other laws or regulations? Explain:
☐ Yes	X No	10. Does permit change require or include ownership, control, right-of-entry, or compliance information?
X Yes	☐ No	11. Does the permit change affect the surface landowner or change the post mining land use?
☐ Yes	X No	12. Does permit change require or include collection and reporting of any baseline information?
X Yes	☐ No	13. Could the permit change have any effect on wildlife or vegetation outside the current disturbed area?
X Yes	☐ No	14. Does permit change require or include soil removal, storage or placement?
X Yes	☐ No	15. Does permit change require or include vegetation monitoring, removal or revegetation activities?
☐ Yes	X No	16. Does permit change require or include construction, modification, or removal of surface facilities?
X Yes	☐ No	17. Does permit change require or include water monitoring, sediment or drainage control measures?
☐ Yes	X No	18. Does permit change require or include certified designs, maps, or calculations?
☐ Yes	X No	19. Does permit change require or include underground design or mine sequence and timing?
☐ Yes	X No	20. Does permit change require or include subsidence control or monitoring?
☐ Yes	X No	21. Have reclamation costs for bonding been provided or revised for any change in the reclamation plan?
X Yes	☐ No	22. Is permit change within 100 feet of a public road or perennial stream or 500 feet of an occupied dwelling?
X Yes	☐ No	23. Is this permit change coal exploration activity X inside ☐ outside of the permit area?

X Attach 3 complete copies of proposed permit change as it would be incorporated into the Mining and Reclamation Plan.

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

Kenneth E. May
Signed - Name - Position - Date

Subscribed and sworn to before me this 6th day of June, 1994.

Jill White
Notary Public

My Commission Expires: March 28, 1996

Attest: STATE OF Utah
COUNTY OF Sanpete

Notary Public
JILL WHITE
59 West 200 South
Gunnison, Utah 84634
My Commission Expires
March 28, 1996
State of Utah

RECEIVED
JUN - 8 1994
DIV. OF OIL, GAS & MINING

Received by Oil, Gas & Mining

ASSIGNED PERMIT CHANGE NUMBER

Application for Permit Change
Detailed Schedule of Changes to the Permit

Title of Change:	Permit Number: ACT / 041/ 002 /
Exploration Drilling	Mine: SUFCO Mine
	Permittee: Coastal States Energy

Provide a detailed listing of all changes to the mining and reclamation plan which will be required as a result of this proposed permit change. Individually list all maps and drawings which are to be added, replaced, or removed from the plan. Include changes of the table of contents, section of the plan, pages, or other information as needed to specifically locate, identify and revise the exiting mining and reclamation plan. **Include page, section and drawing numbers as part of the description.**

			DESCRIPTION OF MAP, TEXT, OR MATERIALS TO BE CHANGED
☐ ADD	X REPLACE	☐ REMOVE	former page 6-ii with new page 6-ii in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-iii with new page 6-iii in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-iv behind new page 6-iii in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-2 with new page 6-2 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-4 with new page 6-4 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-7 with new page 6-7 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-8 with new page 6-8 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-11 with new page 6-11 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-12 with new page 6-12 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-13 with new page 6-13 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-14 with new page 6-14 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-15 behind new page 6-14 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-16 behind new page 6-15 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-15 with new page 6-17 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-18 behind new page 6-17 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-19 behind new page 6-18 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-20 behind new page 6-19 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-16 with new page 6-21 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former Plate 6-1 with new Plate 6-1 in Chapter 6 Geology
☐ ADD	☐ REPLACE	☐ REMOVE	
☐ ADD	☐ REPLACE	☐ REMOVE	
☐ ADD	☐ REPLACE	☐ REMOVE	
☐ ADD	☐ REPLACE	☐ REMOVE	

Any other specific or special instructions required for insertion of this proposal into the Mining and Reclamation Plan?

Page 6-20 starts a new section (6.50 Reclamation) which was not in the original M&RP. A tab divider should precede this page.

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(Appendices appear in Volumes 7 and 8)

Appendix

6.20 Environmental Description

This section presents a description of the geologic resources in the area of the SUFCo Mine.

6.2.1 General Requirements

This section presents the regional and site-specific geologic information for the SUFCo Mine area. The site-specific geologic information for the adjacent waste rock disposal site is contained in Volume 3, Part 2.2.

6.2.2 Cross Sections, Maps and Plans

Plate 6-1 presents the surficial geology of the site area, the coal outcrop lines and the strike and dip of the coal seam mined. Plate 6-1 also presents the locations of the drillholes in the mine area. Elevations are given for the drillholes which were logged and sampled. These logs are presented in Appendix 6-1.

The geologic cross-section, presented in Plate 6-2, displays the depth and thickness of the coal seams together with their surrounding lithology and the lateral correlation of coal seams using the following drillholes and measured underground mine sections.

- MC-80-16-7
- MC-80-17-8C
- TP-1
- 76-29-Y
- 2L4E (Underground)
- US-77-5
- 76-32-J
- 76-32-I
- US-79-14
- 2R5E (Underground)
- US-79-17
- US-79-10
- US-79-8

(Figure 6-1 presents the generalized stratigraphic section for the mine area.)

The Applicant has a Resource Recovery and Protection Plan (R2P2) on file with the Bureau of Land Management. This R2P2 contains a detailed discription of the two mineable coal seams on the SUFCo leasehold. The overlying Duncan Seam is not considered mineable (see Section 5.2.2).

No oil or gas wells are known to exist within a quarter mile of the mine area. No other water wells have been drilled in the permit area except those drilled by the applicant for the purpose of monitoring the groundwater.

6.2.3 Geologic Determinations

The information required by UDOGM to make a determination of the acid or toxic forming characteristics of the site strata is presented in Section 6.2.4.3 of this M&RP.

The information required by UDOGM to make a determination as to whether the reclamation plan, described in Section 5.40, can be accomplished is presented in Section 6.2.4.

The information required to prepare the subsidence control program is addressed in Section 6.2.4.

6.2.4 Geologic Information

6.2.4.1 Regional Setting

The SUFCo Mine is located beneath the Old Woman Plateau, 20 miles east of Salina, Utah. The Old Woman Plateau lies in the Wasatch Plateau Subprovince of the Colorado Plateau Physiographic Province.

Stratigraphy. All rock units within the SUFCo Mine property boundaries are sedimentary (Plate 6-1 and Figure 6-1). No igneous or metamorphic units are found in the area. Most exposed, consolidated sedimentary rocks in the area were deposited during the Cretaceous Age of the Mesozoic Era. The upper North Horn Formation is lower Tertiary (Paleocene) in

laterally into siltstones and shale. Most of the coal seams in the Upper Blackhawk Member occur in the lower 200 feet, with the thicker coal seams occurring in the lower 150 feet.

Three coal seams with thickness greater than five feet (the Upper Hiawatha Seam and two others of lesser importance; the Lower Hiawatha Seam and the Duncan Seam) are found in the Blackhawk Formation within the mine property (Plate 6-1). The Upper Hiawatha Seam is the only one of the three which is continuous within the mine property boundaries. This seam has a thickness of between 9 and 18 feet over most of the property but thins sufficiently due to a mid-seam parting in the southeastern portion of the property that it becomes unmineable. The Lower Hiawatha Seam occurs in the interval between the Upper Hiawatha Seam and the Star Point Sandstone. It is 2 to 29 feet above the Star Point Sandstone. The interval between the two coal seams varies, between 5.6 and 47.5 feet. The Lower Hiawatha Seam is thin and discontinuous, varying in thickness from 0 to 5.9 feet. The seam is rendered unminable over much of the property due to partings. The Lower Hiawatha seam is only considered to be mineable where the interburden between the Upper Hiawatha seam is greater than 30 feet. This condition and a sufficient mining height occurs only in the northwest corner of the SUFCo property.

The third coal seam occurs 100 to 130 feet above the Upper Hiawatha and has been informally named the Duncan Seam by SUFCo. The Duncan seam occurs about 100 to 130 feet above the Upper Hiawatha seam in a small portion of lease U-28297. Because it is of such limited lateral extent, it cannot be correlated with any coal seams in areas surrounding the SUFCo property. It has a maximum thickness of ten feet and is not mineable because of its limited lateral extent The unsplit area of the Duncan seam is of small extent, probably less than 50 acres.

The Upper Member of the Blackhawk Formation generally forms a steep, irregular slope between the cliffs of the underlying Star Point Sandstone and the overlying Castlegate Sandstone. Ledges of sandstone up to 50 feet thick break the slope. In some exposures, the unit is nearly vertical where the Star Point below has sheared off and erosion has not brought the slope to equilibrium. In Convulsion and Quitchupah Canyons, there are large areas of coal burn where the coal has burned naturally and baked the enveloping clays and sandstones to

form a resistant reddish clinker layer. These areas are generally steeper than the surrounding slopes. Vegetative cover is generally sparse such that the Upper Blackhawk strata can be easily seen except on some north-facing slopes where vegetation masks the unit.

Price River Formation-Castlegate Sandstone Member

The Castlegate Sandstone extends across the eastern part of Utah, along part of the Bookcliffs and the entire length of the Wasatch Plateau (Spieker, 1931) but loses its character as a cliff-former south of the Interstate Highway 70. It is correlative to the Cliffhouse Sandstone of southwestern Colorado and northern New Mexico (McGookey, 1973). In the Wasatch Plateau, its thickness varies from 50 to 500 feet (Spieker, 1931). It is thickest in Price River Canyon at the north end of the Wasatch Plateau. The Castlegate Sandstone is exposed along the rims of Convulsion and North Fork of Quitchupah Canyons. Its thickness varies across the SUFCo property from about 120 to 260 feet with a general northwestward thickening.

The Castlegate Sandstone is a fluvial deposit composed mostly of sandstone, conglomeratic sandstone, pebble conglomerate, and gritstone lenses. There are some thin interbeds of siltstone and claystone, especially toward the base of the unit. The member forms much of the surface of Old Woman Plateau in the southern part of the mine property, and creates a nearly unbroken cliff along the canyons which flank the SUFCo Mine on the south and east.

Price River Formation - Upper Member

The Upper Member of the Price River Formation is the uppermost member of the Mesa Verde group and in the vicinity of the mine it caps the mesa which forms the Old Woman Plateau. The formation is reported to be approximately 550 feet thick in the mine area.

The Upper Price River Formation consists of gray to white gritty sandstone, interbedded with subordinate shale and conglomerate. The formation is resistant to weathering and is a ledge and slope former due to interbedding of resistant sandstones with less resistant shales and claystones.

The as-mined quality of the Upper Hiawatha coal seam averages 11,500 BTU, 9.4% ash, 8% moisture, 38% volatile matter and 44% fixed carbon.

The Duncan Coal Seam will not be mined as a part of the SUFCo Mine operations because it is discontinuous and has insufficient minable reserves. The Lower Hiawatha Coal Seam will only be mined in the western portion of the Quitchupah lease because this is the only area where the coal is thick enough to mine and there is sufficient interburden between the Upper and Lower Hiawatha seams to allow mining.

Cross-Sections, Maps and Plans. The cross-sections and maps are discussed in Section 6.2.4 and are located at the end of this chapter. The applicant request's that this information remain confidential.

Drill Logs and Chemical Analyses. See Section 6.2.4.3 and Appendices 6-1 and 6-2. The applicant requests that this information remain confidential and that public access to these sections be limited to only perons with an interest which is or may be adversely affected as provided under Section 40-10-10(4) of the Act.

6.2.4.2 Test Boring and Drillhole Data (overburden removed)

SUFCo does not plan to remove any overburden above the coal seam to be mined. Regulations related to overburden removal do not apply to this M&RP.

6.2.4.3 Test Boring and Drillhole Data (overburden not removed)

The drill logs and chemical analyses required by regulations 614-301-624.310 through 614-301-624.330 are presented in Appendices 6-1 and 6-2.

Lithologic Logs. Lithologic logs of drillholes are presented in Appendix 6-1. The applicant requests that this information be kept confidential and that public access to these sections be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10(4) of the Act.

Acid, Toxic, and Alkaline Chemical Analyses (above and below the coal seam). Chemical analyses for acid- and toxic-forming and alkalinity-producing materials from the waste rock disposal site and roof and floor rock material from drill cores is presented in Appendix 6-2. Using Table 2 in the Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining (Appendix 6-3), only two unacceptable values have been reported. The waste rock disposal site samples are taken quarterly and are considered to be representative of roof, floor, and partings. The boron concentration of the waste rock disposal site sample taken in the second quarter of 1991 exceeds the acceptable level of 5.0 ppm by only 0.44 ppm; therefore, this boron value is not of significant concern. Secondly, the SAR value of 19.30 for the Upper Hiawatha coal seam in drillhole 89-20-2 is unacceptable. However, as there have been no other unacceptable SAR values since this sample was taken, it is probably due to contamination, lab error or sampling error. Analytical results of all other samples are acceptable.

Acid, Toxic, and Alkaline Chemical Analyses (coal seam). The chemical analyses discussed above are also representative of the coal seam mined. Additionally, analyses of pyrite and sulfur forms have been performed on roof, parting, and floor samples taken from various core holes. The results of these analyses are reported in Appendix 6-2.

Properties of Rocks in Room and Pillar Areas. Room and pillar mining is now only used in the stream buffer zones and beneath escarpments to prevent subsidence. Pillars are not removed in these areas.

The clay content of floor samples was not determined analytically. The lithology of the stratum immediately below the minable coal varies from drillhole to drillhole. Therefore, the clay content will range from almost 100% (pure claystone) to less than 5% (submature or mature sandstone). Drillholes 74-36-5, 76-28-K, 76-29-Y, US-79-14, US-79-15 and US-81-4 penetrate the stratum immediately below the coal seam to be mined. Lithologic logs for these drillholes (which include lithotypes of the stratum immediately below the coal seam to be mined) are presented in Appendix 6-1. No engineering properties for the underlying claystone have been determined, because of its friable nature sample preparation is next to impossible.

6.2.5 Additional Geologic Information

It is not anticipated that any additional geologic data will need to be collected for this site.

6.2.6 Sampling Waivers

SUFCo does not request a sampling waiver for this site.

6.2.7 Description of the Overburden Thickness and Lithology

Overburden thickness above the coal seam varies due to the plateau and canyon-type topography from approximately 600 to 1800 feet and averages about 800 feet. Stratigraphically, the overburden consists of the Upper Blackhawk Formation which contains the coal seams, the Castlegate Sandstone Member, the Upper Price River Formation, and the North Horn Formation, as described in Section 6.2.4.1 of this M&RP.

6.30 Operation Plan

6.3.1 Casing and Sealing of Exploration Holes

The information addressing regulations for casing and sealing of exploration holes is found in Section 7.6.5 of this M&RP. This includes both the temporary and permanent casing and sealing of drilled holes and exploration holes and boreholes. The applicant believes all exploration boreholes that have not been used for piezometers have been plugged properly prior to abandonment as required by the regulatory authority. This plugging was the final step in the drilling process prior to abandonment of the well.

6.3.2 Subsidence Monitoring

Subsidence and subsidence monitoring points are discussed in detail in Section 5.2.5 of this M&RP. The extent of the subsidence is shown on Plate 5-10.

6.3.3 Exploration Drilling

The purpose of exploration drilling is to obtain stratigraphic and coal quality information to make for more accurate mine planning and maintain a high level of miner safety. The exploration area is located within the current mining permit boundary of Permit ACT/041/002 as shown on Plate 6-1. SUFCO intends to drill 14 drill holes over a 3 year period (Table 1). No other exploration method is intended. SUFCO understands that the U. S. Forest Service will approve exploration drilling activities on a year-by-year basis. Thus SUFCO will not proceed with drilling until U. S. Forest Service approval is granted.

Drill site preparation, drilling, and final reclamation work will last approximately two weeks per year. Reclamation will be concurrent with drilling to minimize the duration of the project.

The type of exploration to be used is rotary drilling using a 2,000 ft rated drill rig. The drilling procedure will be as follows: rotary drill using a tri-cone bit to core point, core the coal intervals using air with a diamond or carbide bit, ream the cored interval and rotary drill to

TABLE 1
EXPLORATION DRILLING TIMETABLE

YEAR	DRILL HOLE	LOCATION (T, R, Sec)	-FEET OF ACCESS ROUTE FROM USFS ROAD- (Using Existing Wheel Tracks or Surface)	(Using Newly Built Road)	DRILL PAD ACREAGE	TOTAL DISTURBED ACREAGE (New Road + Drill Pads)
1994	94-22-1	21S, 5E, 22, SW	0	1200	0.11	0.44
	94-22-2	21S, 5E, 22, SW	3100	0	0.11	0.11
	94-27-1	21S, 5E, 27, NW	4000	300	0.11	0.19
	94-27-2	21S, 5E, 27, SW	2700	600	0.11	0.28
						TOTAL 1.02
1995	95-16-1	21S, 5E, 16, SW	1900	0	0.11	0.11
	95-17-1	21S, 5E, 17, SE	2800	0	0.11	0.11
	95-17-2	21S, 5E, 17, NW	2700	1500	0.11	0.52
	95-17-3	21S, 5E, 17, NE	2100	800	0.11	0.33
	95-20-1	21S, 5E, 20, NE	1500	0	0.11	0.11
	95-21-1	21S, 5E, 21, NW	2100	0	0.11	0.11
						TOTAL 1.29
1996	96-13-1	21S, 4E, 24, SW	1800	0	0.11	0.11
	96-24-1	21S, 4E, 24, SW	200	0	0.11	0.11
	96-33-1	21S, 5E, 33, NW	2600	600	0.11	0.28
	96-34-1	21S, 5E, 34, NE	5400	0	0.11	0.11
						TOTAL 0.61

total depth. Air will be used as a drilling medium as much as possible though conditions may warrant water, foam or mud. Upon completion of drilling, the holes will be geophysically logged then plugged the full depth with concrete. A total of 0.15 acre-feet of water will be pumped from the North Fork of Quitchupah Creek for use during drilling and hole plugging operations. No coal will be removed beyond that which is cored.

Some of the drill sites will be accessed using existing wheel tracks or over the existing surface and a few will require that new roads be built off of U. S. Forest Service roads or existing wheel tracks (see amended Plate 6-1).

The drill sites will be approximately 50 feet by 100 feet in size. One half of the site will be for the drill rig and water truck while the other half will have 1 to 2 mud pits and temporary supply storage.

The applicant requests that any information from exploration drilling be kept confidential and that public access to any of the information be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10 (4) of the Act.

6.3.4 Exploration Hole Reclamation

The exploration holes will be filled with concrete through their full depth after exploration activities are completed. This will be done by pumping concrete through the drill pipe which hangs 40-60 ft. off the bottom of the hole until the hole up to the drill pipe is filled. The drill pipe is then tripped-out another 40-60 ft. and more concrete pumped into the hole. This process is repeated until the full depth of the hole is filled and good drill hole wall to concrete contact is assured.

6.40 Performance Standards

6.4.1 Exploration and Drillholes

The performance standards used in the casing and sealing of all exploration holes and drillholes are outlined in Section 7.6.5 of this M&RP.

6.4.2 Monuments and Surface Markers of Subsidence Monitoring Points

The performance standards used in the reclamation of all monuments and surface markers used as subsidence monitoring points are outlined in Section 5.2.5.

6.4.3 Exploration Drilling

6.4.3.1 Exploration Activities

During drill site preparation, drilling and reclamation, any trash or contamination that may result from these activities, will be removed from the site. Trash and contaminants will be disposed of in an approved disposal site.

No heavy equipment will be moved if the ground is soft and rutting potential exists. All travel will stay within a twelve-foot wide track. All drilling and related equipment will be promptly removed from the exploration area when no longer needed.

The applicant's representative will, while in the exploration area, have a copy of the Division Approval for Exploration within the permit area available for review.

6.4.3.2 Soils

Where topsoil and subsoil are removed for drill site construction the methods described in Chapter 2 Soils Section 2.3.1.1 will be followed. Soil will be salvaged to at least a 12 inch

depth or the full soil depth from drill sites and constructed roads to consolidated material, whichever is less. Wheel tracks used to access drill sites are considered minor disturbance as described in R645-301-232.400 and will be treated as described in Chapter 2 Soils Section 2.3.2.4. Due to the short time topsoil and subsoil will be stockpiled and the small amount stockpiled, it will not be vegetated. All topsoil and subsoil stockpiles will be completely surrounded by a properly constructed silt fence.

Soil from constructed roads will be salvaged by pushing it into a berm and protected by diverting water away from the berm. The soil in wheel tracks will be ripped then scarified prior to reseeding.

6.4.3.3 Biology

The performance standards described in Chapter 3 Biology Section 3.5 will be followed during drill site and wheel track reclamation. A raptor survey will be done in the Spring of 1994 and the new information will be used to ensure that nesting sites are not disturbed during drilling. Exploration activities (drilling, dirt work and reclamation) will only occur between August 1 and December 1. The mitigation requested by the U. S. Forest Service NEPA documentation for the loss of water from the North Fork of Quitchupah Creek will be satisfied. No trees having cavities which could be used by nesting migratory birds of high federal interest will be removed during the exploration activities.

6.4.3.4 Hydrology

The performance standards described in Chapter 7 Hydrology will be followed where applicable during the exploration period. Though sediment yield will be negligible, sediment from drill sites will be controlled by either a properly constructed silt fence located at the lowest point on each drill site or by diverting all run-off from each drill site into the mud pit. Sediment from topsoil and subsoil stockpiles will be controlled by a silt fence around their base.

Sedimentation control from newly built temporary roads will meet that described in R 742-410 while the roads are in use. Reclamation of those roads will follow that described in Chapter 7 Hydrology, Section 7.60, to ensure post-use sedimentation control.

6.4.3.5 Archaeology

An archaeological survey will be conducted prior to site preparation, drilling activities and use of wheel tracks for those areas which have not been previously surveyed. Should cultural or historical resources be found during these activities the activity will be stopped and the UDOGM notified.

6.4.3.6 Acid or Toxic-Forming Materials

No acid or toxic-forming materials have been encountered previously and thus are not expected to be encountered during this drilling program. The addition of suspended solids to streams will be negligible due to the small areas disturbed, the short life of the drilling program and sediment control measures that will be used.

6.50 Reclamation

6.5.1 Wheel Tracks and Drill Sites

Wheel tracks will be reclaimed by ripping followed by scarifying the soil and reseeding. Drill sites will be reclaimed by first replacing the material excavated for the mudpits, distributing the soil, and lastly reseeding. The seed mix given in Chapter 3, Biology Section 3.4.1.2 will be used with the following changes: mountain big sage brush, Kentucky bluegrass, snowberry and curl leaf mountain mahogany added to the mix; "whitestem" rubber rabbit brush substituted for rubber rabbit brush, Rocky Mountain penstemon substituted for Palmer Penstemon, Pacific aster substituted for blue leaf aster; and corymb buckwheat deleted. The application rate for Kentucky bluegrass, snowberry and curl leaf mountain mahogany is one pound pure live seed per acre. U. S. Forest Service certified noxious weed free straw or hay will be used as mulch.

Revegetation success will be determined using the Erosion Condition Classification System developed by OSMRE and by comparison to established reference areas. The reference areas will be undisturbed areas of a similar vegetative type adjacent to the drill sites. Equipment used to reclaim wheel tracks, build roads and drill sites will be either a D-7 or D-8 size dozer or a road grader to fill mud pits, redistribute soils, and rip and scarify wheel tracks.

6.5.2 Permanent Casing and Sealing of Wells

All drill holes will be plugged with concrete as described in Chapter 7 Hydrology section 7.6.5. A permanent marker will be placed at the top of each drill hole bearing the drill hole number.

REFERENCES:

Davis, F.D. and Doelling, H.H. 1976. Drilling of Low Sulfur Bituminous Coals in Several Areas of the Wasatch Plateau Coal Field, Utah. UGMS OFR 17.

Doelling, H.H. 1972. Central Utah Coal Fields: Sevier-Sanpete, Wasatch Plateau, Bookcliffs and Emery. UGMS Mon. Ser. 3, p 570.

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SUFCo. Personal communication by Larry Trimble, field reconnaissance. Salina, Utah.

Coastal
The Energy People

KENNETH E. MAY
GENERAL MANAGER
SOUTHERN UTAH FUEL COMPANY

January 20, 1994

Mr. Daron Haddock
Permitting Supervisor
Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

Dear Mr. Haddock:

Enclosed please find three copies of SUFCO's Application for Permit Change addressing exploration drilling. Please note that this application addresses the changes UDOGM requested in the deficiency letter dated January 4, 1994 and clarified in our meeting on January 11, 1994, but does not include changes requested by the United States Forest Service. We agreed to submit a new application reflecting UDOGM's changes at this time and will address those from the U. S. Forest Service once they are submitted to UDOGM.

Please let us know if you have any questions. Thank you for your help.

Sincerely,
SOUTHERN UTAH FUEL COMPANY

Kenneth E. May
General Manager

KM/CMK:jad

Enclosures

Southern Utah Fuel Company
A SUBSIDIARY OF THE COASTAL CORPORATION
397 SOUTH 800 WEST • SALINA UT 84654 • 801 637-4880 • FAX 801/534-3296

APPLICATION FOR PERMIT CHANGE

Title of Change:	Permit Number: ACT / 041 / 002
Exploration Drilling	Mine: SUFCo Mine
	Permittee: Coastal States Energy Co.

Description, include reason for change and timing required to implement:

This permit change addresses exploration drilling and related activities which were not addressed in the recent M&RP. The permit change must be approved by April 1994.

☐ Yes	X No	1. Change in the size of the Permit Area? _____ acres ☐ increase ☐ decrease.
X Yes	☐ No	2. Change in the size of the Disturbed Area? 6.3 acres X increase ☐ decrease.
☐ Yes	X No	3. Will permit change include operations outside the Cumulative Hydrologic Impact Area?
☐ Yes	X No	4. Will permit change include operations in hydrologic basins other than currently approved?
☐ Yes	X No	5. Does permit change result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes	X No	6. Does permit change require or include public notice publication?
☐ Yes	X No	7. Permit change as a result of a Violation? Violation #
☐ Yes	X No	8. Permit change as a result of a Division Order? D.O.#
☐ Yes	X No	9. Permit change as a result of other laws or regulations? Explain:
☐ Yes	X No	10. Does permit change require or include ownership, control, right-of-entry, or compliance information?
X Yes	☐ No	11. Does the permit change affect the surface landowner or change the post mining land use?
☐ Yes	X No	12. Does permit change require or include collection and reporting of any baseline information?
X Yes	☐ No	13. Could the permit change have any effect on wildlife or vegetation outside the current disturbed area?
X Yes	☐ No	14. Does permit change require or include soil removal, storage or placement?
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☐ Yes	X No	16. Does permit change require or include construction, modification, or removal of surface facilities?
X Yes	☐ No	17. Does permit change require or include water monitoring, sediment or drainage control measures?
☐ Yes	X No	18. Does permit change require or include certified designs, maps, or calculations?
☐ Yes	X No	19. Does permit change require or include underground design or mine sequence and timing?
☐ Yes	X No	20. Does permit change require or include subsidence control or monitoring?
☐ Yes	X No	21. Have reclamation costs for bonding been provided or revised for any change in the reclamation plan?
X Yes	☐ No	22. Is permit change within 100 feet of a public road or perennial stream or 500 feet of an occupied dwelling?
X Yes	☐ No	23. Is this permit change coal exploration activity X inside ☐ outside of the permit area?

X Attach 3 complete copies of proposed permit change as it would be incorporated into the Mining and Reclamation Plan.

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

_____

Signed - Name - Position - Date

Subscribed and sworn to before me this ____ day of _____, 19 _____.

_____

Notary Public

My Commission Expires: _____, 19_____

Attest: STATE OF _____ } ss:

COUNTY OF _____ }

Received by Oil, Gas & Mining

ASSIGNED PERMIT CHANGE NUMBER

Application for Permit Change
Detailed Schedule of Changes to the Permit

Title of Change:

Exploration Drilling

Permit Number: ACT / 041 / 002

Mine: SUFCo Mine

Permittee: Coastal States Energy Co.

Provide a detailed listing of all changes to the mining and reclamation plan which will be required as a result of this proposed permit change. Individually list all maps and drawings which are to be added, replaced, or removed from the plan. Include changes of the table of contents, section of the plan, pages, or other information as needed to specifically locate, identify and revise the exiting mining and reclamation plan. **Include page, section and drawing numbers as part of the description.**

			DESCRIPTION OF MAP, TEXT, OR MATERIALS TO BE CHANGED
☐ ADD	X REPLACE	☐ REMOVE	former page 6-ii with new page 6-ii in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-iii with new page 6-iii in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-iv behind new page 6-iii in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-14 with new page 6-14 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-15 behind new page 6-14 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-15 with new page 6-16 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-17 behind new page 6-16 in Chapter 6 Geology
X ADD	☐ REPLACE	☐ REMOVE	new page 6-18 behind new page 6-17 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former page 6-16 with new page 6-19 in Chapter 6 Geology
☐ ADD	X REPLACE	☐ REMOVE	former Plate 6-1 with new Plate 6-1 in Chapter 6 Geology
☐ ADD	☐ REPLACE	☐ REMOVE	
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Any other specific or special instructions required for insertion of this proposal into the Mining and Reclamation Plan?

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6.30 Operation Plan

6.3.1 Casing and Sealing of Exploration Holes

The information addressing regulations for casing and sealing of exploration holes is found in Section 7.6.5 of this M&RP. This includes both the temporary and permanent casing and sealing of drilled holes and exploration holes and boreholes. The applicant believes all exploration boreholes that have not been used for piezometers have been plugged properly prior to abandonment as required by the regulatory authority. This plugging was the final step in the drilling process prior to abandonment of the well.

6.3.2 Subsidence Monitoring

Subsidence and subsidence monitoring points are discussed in detail in Section 5.2.5 of this M&RP. The extent of the subsidence is shown on Plate 5-10.

6.3.3 Exploration Drilling

The purpose of exploration drilling is to obtain stratigraphic and coal quality information to make for more accurate mine planning and maintain a high level of miner safety. The exploration area is located within the current mining permit boundary of Permit ACT/041/002 as shown on Plate 6-1. SUFCO intends to drill 14 drill holes over a 3 year period. No other exploration method is intended. The drilling timetable is: 1994 -- 4 drill holes, 1995 -- 5 drill holes, and 1996 -- 5 drill holes.

Drill site preparation, drilling, and final reclamation work will last approximately two weeks per year. Reclamation will be concurrent with drilling to minimize the duration of the project.

The type of exploration to be used is rotary drilling using a 2,000 ft rated drill rig. The drilling procedure will be as follows: rotary drill using a tri-cone bit to core point, core the coal intervals using air with a diamond or carbide bit, ream the cored interval and rotary drill to total depth. Air will be used as a drilling medium as much as possible though conditions may

warrant water, foam or mud. Upon completion of drilling, the holes will be geophysically logged then plugged the full depth with concrete. A total of 0.15 acre-feet of water will be pumped from the North Fork of Quitchupah Creek for use during drilling and hole plugging operations. No coal will be removed beyond that which is cored.

Some of the drill sites will be accessed using existing wheel tracks and a few will require that roads be built off of U. S. Forest Service roads or existing wheel tracks (see amended Plate 6-1).

The drill sites will be approximately 50 feet by 100 feet in size. One half of the site will be for the drill rig and water truck while the other half will have 1 to 2 mud pits and temporary supply storage.

The applicant requests that any information from exploration drilling be kept confidential and that public access to any of the information be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10 (4) of the Act.

6.3.4 Exploration Hole Reclamation

The exploration holes will be filled with concrete through their full depth after exploration activities are completed. This will be done by pumping concrete through the drill pipe which hangs 40-60 ft. off the bottom of the hole until the hole up to the drill pipe is filled. The drill pipe is then tripped-out another 40-60 ft. and more concrete pumped into the hole. This process is repeated until the full depth of the hole is filled and good drill hole wall to concrete contact is assured.

6.40 Performance Standards

6.4.1 Exploration and Drillholes

The performance standards used in the casing and sealing of all exploration holes and drillholes are outlined in Section 7.6.5 of this M&RP.

6.4.2 Monuments and Surface Markers of Subsidence Monitoring Points

The performance standards used in the reclamation of all monuments and surface markers used as subsidence monitoring points are outlined in Section 5.2.5.

6.4.3 Exploration Drilling

6.4.3.1 Exploration Activities

During drill site preparation, drilling and reclamation, any trash or contamination that may result from these activities, will be removed from the site. Trash and contaminants will be disposed of in an approved disposal site.

All drilling and related equipment will be promptly removed from the exploration area when no longer needed.

The applicant's representative will, while in the exploration area, have a copy of the Division Approval for Exploration within the permit area available for review.

6.4.3.2 Soils

Where topsoil and subsoil are removed for drill site construction the methods described in Chapter 2 Soils Section 2.3.1.1 will be followed. Soil will be salvaged to at least a 12 inch depth or the full soil depth from drill sites and constructed roads to consolidated material, whichever is less. Wheel tracks used to access drill sites are considered minor disturbance

as described in R645-301-232.400 and will be treated as described in Chapter 2 Soils Section 2.3.2.4. Due to the short time topsoil and subsoil will be stockpiled and the small amount stockpiled, it will not be vegetated. All topsoil and subsoil stockpiles will be completely surrounded by a properly constructed silt fence.

Soil from constructed roads will be salvaged by pushing it into a berm and protected by diverting water away from the berm. The soil in wheel tracks will be ripped then scarified prior to reseeding.

6.4.3.3 Biology

The performance standards described in Chapter 3 Biology Section 3.5 will be followed during drill site and wheel track reclamation. A raptor survey will be done in the Spring of 1994 and the new information will be used to ensure that nesting sites are not disturbed during drilling. Exploration activities (drilling, dirt work and reclamation) will only occur between August 1 and December 1. The mitigation requested by the U. S. Forest Service NEPA documentation for the loss of water from the North Fork of Quitchupah Creek will be satisfied.

6.4.3.4 Hydrology

The performance standards described in Chapter 7 Hydrology will be followed where applicable during the exploration period. Siltation structures and impoundments will not be constructed.

6.4.3.5 Archaeology

An archaeological survey will be conducted prior to site preparation, drilling activities and use of wheel tracks for those areas which have not been previously surveyed. Should cultural or historical resources be found during these activities the activity will be stopped and the UDOGM notified.

6.4.3.6 Acid or Toxic-Forming Materials

No acid or toxic-forming materials have been encountered previously and thus are not expected to be encountered during this drilling program. The addition of suspended solids to streams will be negligible due to the short life of access roads and drill sites.

6.50 Reclamation

6.5.1 Wheel Tracks and Drill Sites

Wheel tracks will be reclaimed by ripping followed by scarifying the soil and reseeding. Drill sites will be reclaimed by first replacing the material excavated for the mudpits, distributing the soil, and lastly reseeding. The seed mix given in Chapter 3, Biology Section 3.4.1.2 will be used with the following changes: mountain big sage brush, Kentucky bluegrass, snowberry and curl leaf mountain mahogany added to the mix; "whitestem" rubber rabbit brush substituted for rubber rabbit brush, Rocky Mountain penstemon substituted for Palmer Penstemon, Pacific aster substituted for blue leaf aster; and corymb buckwheat deleted. The application rate for Kentucky bluegrass, snowberry and curl leaf mountain mahogany is one pound pure live seed per acre. U. S. Forest Service certified noxious weed free straw or hay will be used as mulch.

Revegetation success will be determined using the Erosion Condition Classification System, developed by OSMRE.

6.5.2 Permanent Casing and Sealing of Wells

All drill holes will be plugged with concrete as described in Chapter 7 Hydrology section 7.6.5. A permanent marker will be placed at the top of each drill hole bearing the drill hole number.

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Davis, F.D. and Doelling, H.H. 1976. Drilling of Low Sulfur Bituminous Coals in Several Areas of the Wasatch Plateau Coal Field, Utah. UGMS OFR 17.

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SUFCo. Personal communication by Larry Trimble, field reconnaissance. Salina, Utah.

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6.40 Performance Standards

6.4.1 Exploration and Drillholes

The performance standards used in the casing and sealing of all exploration holes and drillholes are outlined in Section 7.6.5 of this M&RP.

6.4.2 Monuments and Surface Markers of Subsidence Monitoring Points

The performance standards used in the reclamation of all monuments and surface markers used as subsidence monitoring points are outlined in Section 5.2.5.

6.4.3 Exploration Drilling

6.4.3.1 Exploration Activities

During drill site preparation, drilling and reclamation, any trash or contamination that may result from these activities, will be removed from the site. Trash and contaminants will be disposed of in an approved disposal site.

All drilling and related equipment will be promptly removed from the exploration area when no longer needed.

The applicant's representative will, while in the exploration area, have a copy of the Division Approval for Exploration within the permit area available for review.

6.4.3.2 Soils

Where topsoil and subsoil are removed for drill site construction the methods described in Chapter 2 Soils Section 2.3.1.1 will be followed. Wheel tracks used to access drill sites are considered minor disturbance as described in R645-301-232.400 and will be treated as described in Chapter 2 Soils Section 2.3.2.4. The soil in wheel tracks will be scarified prior

to reseeding. Due to the short time topsoil and subsoil will be stockpiled and the small amount stockpiled, it will not be vegetated. All topsoil and subsoil stockpiles will be completely surrounded by a properly constructed silt fence.

6.4.3.3 Biology

The performance standards described in Chapter 3 Biology Section 3.5 will be followed during drill site and wheel track reclamation. Drilling operations will not occur within 1500 ft of known raptor nesting sites. A raptor survey will be done in the Spring of 1994 and the new information will be used to ensure that nesting sites are not disturbed during drilling.

6.4.3.4 Hydrology

The performance standards described in Chapter 7 Hydrology will be followed where applicable during the exploration period. Siltation structures and impoundments will not be constructed.

6.4.3.5 Archaeology

An archaeological survey will be conducted prior to site preparation, drilling activities and use of wheel tracks for those areas which have not been previously surveyed. Should cultural or historical resources be found during these activities the activity will be stopped and the UDOGM notified.

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No acid or toxic-forming materials have been encountered previously and thus are not expected to be encountered during this drilling program. The addition of suspended solids to streams will be negligible due to the short life of access roads and drill sites.

6.50 Reclamation

6.5.1 Wheel Tracks and Drill Sites

Wheel tracks will be reclaimed by scarifying the soil and reseeding with the approved seed mix. Drill sites will be reclaimed by first replacing the material excavated for the mudpits, distributing the subsoil, distributing the topsoil, and lastly reseeding using the seed mix given in Chapter 3, Biology Section 3.4.1.2.

6.5.2 Permanent Casing and Sealing of Wells

All drill holes will be plugged with concrete as described in Chapter 7 Hydrology section 7.6.5. A permanent marker will be placed at the top of each drill hole bearing the drill hole number.

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APPLICATION FOR PERMIT CHANGE

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I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

_____

Signed - Name - Position - Date

Subscribed and sworn to before me this ____ day of _____, 19 ____.

_____

Notary Public

My Commission Expires: _____, 19____

Attest: STATE OF _____ } ss:

COUNTY OF _____ }

Received by Oil, Gas & Mining

93C

ASSIGNED PERMIT CHANGE NUMBER

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6.30 Operation Plan

6.3.1 Casing and Sealing of Exploration Holes

The information addressing regulations for casing and sealing of exploration holes is found in Section 7.6.5 of this M&RP. This includes both the temporary and permanent casing and sealing of drilled holes and exploration holes and boreholes. The applicant believes all exploration boreholes that have not been used for peziometers have been plugged properly prior to abandonment as required by the regulatory authority. This plugging was the final step in the drilling process prior to abandonment of the well.

6.3.2 Subsidence Monitoring

Subsidence and subsidence monitoring points are discussed in detail in Section 5.2.5 of this M&RP. The extent of the subsidence is shown on Plate 5-10.

6.3.3 Exploration Drilling

The purpose of exploration drilling is to obtain stratigraphic and coal quality information to make for more accurate mine planning and maintain a high level of miner safety. The exploration area is located within the current mining permit boundary of Permit ACT/041/002 as shown on Plate 6-1. SUFCO intends to drill 14 drill holes over a 3 year period. No other exploration method is intended. The drilling timetable is: 1994 -- 4 drill holes, 1995 -- 5 drill holes, and 1996 -- 5 drill holes.

Drill site preparation, drilling, and final reclamation work will last approximately two weeks per year. Reclamation will be concurrent with drilling to minimize the duration of the project.

The type of exploration to be used is rotary drilling using a 2,000 ft rated drill rig. The drilling procedure will be as follows: rotary drill using a tri-cone bit to core point, core the coal intervals using air with a diamond or carbide bit, ream the cored interval and rotary drill to total depth. Air will be used as a drilling medium as much as possible though conditions may

warrant water, foam or mud. Upon completion of drilling, the holes will be geophysically logged then plugged the full depth with concrete. A total of 0.15 acre-feet of water will be pumped from the North Fork of Quitchupah Creek for use during drilling and hole plugging operations. No coal will be removed beyond that which is cored.

Some of the drill sites will be accessed using existing wheel tracks and a few will require that roads be built off of U. S. Forest Service roads or existing wheel tracks (see amended Plate 6-1).

The drill sites will be approximately 50 feet by 100 feet in size. One half of the site will be for the drill rig and water truck while the other half will have 1 to 2 mud pits and temporary supply storage.

The applicant requests that any information from exploration drilling be kept confidential and that public access to any of the information be limited to only persons with an interest which is or may be adversely affected as provided under Section 40-10-10 (4) of the Act.

6.3.4 Exploration Hole Reclamation

The exploration holes will be filled with concrete through their full depth after exploration activities are completed. This will be done by pumping concrete through the drill pipe which hangs 40-60 ft. off the bottom of the hole until the hole up to the drill pipe is filled. The drill pipe is then tripped-out another 40-60 ft. and more concrete pumped into the hole. This process is repeated until the full depth of the hole is filled and good drill hole wall to concrete contact is assured.

6.40 Performance Standards

6.4.1 Exploration and Drillholes

The performance standards used in the casing and sealing of all exploration holes and drillholes are outlined in Section 7.6.5 of this M&RP.

6.4.2 Monuments and Surface Markers of Subsidence Monitoring Points

The performance standards used in the reclamation of all monuments and surface markers used as subsidence monitoring points are outlined in Section 5.2.5.

6.4.3 Exploration Drilling

6.4.3.1 Exploration Activities

During drill site preparation, drilling and reclamation, any trash or contamination that may result from these activities, will be removed from the site. Trash and contaminants will be disposed of in an approved disposal site.

All drilling and related equipment will be promptly removed from the exploration area when no longer needed.

The applicant's representative will, while in the exploration area, have a copy of the Division Approval for Exploration within the permit area available for review.

6.4.3.2 Soils

Where topsoil and subsoil are removed for drill site construction the methods described in Chapter 2 Soils Section 2.3.1.1 will be followed. Wheel tracks used to access drill sites are considered minor disturbance as described in R645-301-232.400 and will be treated as described in Chapter 2 Soils Section 2.3.2.4. The soil in wheel tracks will be scarified prior

to reseeding. Due to the short time topsoil and subsoil will be stockpiled and the small amount stockpiled, it will not be vegetated. All topsoil and subsoil stockpiles will be completely surrounded by a properly constructed silt fence.

6.4.3.3 Biology

The performance standards described in Chapter 3 Biology Section 3.5 will be followed during drill site and wheel track reclamation. Drilling operations will not occur within 1500 ft of known raptor nesting sites. A raptor survey will be done in the Spring of 1994 and the new information will be used to ensure that nesting sites are not disturbed during drilling.

6.4.3.4 Hydrology

The performance standards described in Chapter 7 Hydrology will be followed where applicable during the exploration period. Siltation structures and impoundments will not be constructed.

6.4.3.5 Archaeology

An archaeological survey will be conducted prior to site preparation, drilling activities and use of wheel tracks for those areas which have not been previously surveyed. Should cultural or historical resources be found during these activities the activity will be stopped and the UDOGM notified.

6.4.3.6 Acid or Toxic-Forming Materials

No acid or toxic-forming materials have been encountered previously and thus are not expected to be encountered during this drilling program. The addition of suspended solids to streams will be negligible due to the short life of access roads and drill sites.

6.50 Reclamation

6.5.1 Wheel Tracks and Drill Sites

Wheel tracks will be reclaimed by scarifying the soil and reseeding with the approved seed mix. Drill sites will be reclaimed by first replacing the material excavated for the mudpits, distributing the subsoil, distributing the topsoil, and lastly reseeding using the seed mix given in Chapter 3, Biology Section 3.4.1.2.

6.5.2 Permanent Casing and Sealing of Wells

All drill holes will be plugged with concrete as described in Chapter 7 Hydrology section 7.6.5. A permanent marker will be placed at the top of each drill hole bearing the drill hole number.

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